THE

AMERICAN NATURALIST.

Vol. VII. — NOVEMBER, 1873. — No. 11.

THE STRUCTURE AND GROWTH OF DOMESTICATED ANIMALS.*

BY PROF. LOUIS AGASSIZ.

THE subject announced in the programme for this evening's lecture is "The Structure and Growth of Domesticated Animals." It would take a year's course to do justice to the whole subject, and I had therefore to choose a portion of it, and especially such a part as may give you an idea of the difficulties of investigating some of the topics which are, perhaps, of the greatest importance in practical life. It is often expected that science will furnish all the information wanted at a given moment, but unfortunately science is not always ready. My object is to show that you must have knowledge before you can apply it, and that knowledge is not always to be had for the asking. There is not always that information on hand which may be needed even for the most useful purposes; and in order to allay the impatience which is sometimes manifested in respect to the want of usefulness on the part of scientific men and their ability to enter into the arena of practical life, I wish to show you how difficult it is to handle some of the subjects, and I have chosen one respecting which, of course, a farming community supposes that science can furnish all the information wanted.

* Delivered before the State Board of Agriculture at Barre, December 3d, 1872. From the Twentieth Annual Report of the Secretary of the Massachusetts Board of Agriculture. We are indebted to C. L. Flint, Esq., Secretary of the Board, for the use of the accompanying illustrations.

Concerning the anatomy of our domesticated animals there is a great deal known; enough to give a good idea of the peculiarities of the full-grown animals of the different kinds which we raise to use for various purposes. Concerning the functions of their organs, there is also a great deal known, which is of value and service to guide us in our treatment of them. Nobody expects to treat a pig as he treats a horse; and the difference in our management of two such animals is determined by what we know of their structure, by what we know of the functions or the play of their characteristic organs; but there is one topic about which the farmer would like to know more, and that is in reference to breeding; and especially such points in the process of breeding as would enable him to do certain things which would add greatly to the value of our stock. If it were known how to raise male animals in places where it is desirable to have them in larger numbers, if it were known how to raise heifers in those regions where dairy farming is largely carried on, imagine what an advantage it would be to be able to determine beforehand the sex of the animals to be bred. Unfortunately, we do not know enough to-day to guide us in that direction, and yet I have not the remotest doubt that the time is coming when we shall be able to bring forth what we want, as we have been able to produce certain peculiar modifications of the various kinds of domesticated animals to suit our purposes,—when we want beef rather than milk, when we want strength rather than delicacy of structure. Now, how shall we get at it? We have not the information. You may consult the men of science, the most learned men of the day in every part of the world, and they will say, "Upon these topics we have no satisfactory knowledge whatsoever." It is to be reached only by studying the various functions connected with the process of breeding, by studying especially the earlier stages of the growth of animals with which we are familiar, and studying them with reference to that point. Upon that topic I will make a few statements concerning the facts with which I am familiar.

It is not long since all animals were divided into two classes with reference to their breeding. Some were called oviparous—that is, egg-laying animals, which multiply by laying eggs, out of which a young animal is eventually evolved; the others were called viviparous,—such as bring forth living young, after a more or less protracted gestation; and these two classes of animals were sup-

posed to be widely different one from another, both in structure and in mode of reproduction; but less than fifty years ago, a German physiologist, Karl Ernst von Baer, one of the ablest investigators of our century, made the astounding discovery that all animals bring forth eggs that may not be distinguished from one another at a certain stage; that all our cattle, all our domesticated animals, all the beasts of the forest, as well as all the birds on earth, produce eggs similar to one another. This seems a very extraordinary statement, yet perhaps I shall be able to make you familiar with the fact, and to make you understand it as fully as you know that your hens lay eggs. But the eggs of a great many animals most useful to us, and of those about which we would like to know most, have not been studied microscopically. I have devoted a great deal of my life to similar topics, and I have never yet seen the egg of a mare; I have never yet seen the egg of a cow; I have never yet seen the egg of a pig; yet I believe that these animals bring forth eggs as much as the animals that have been investigated with reference to that point. A sufficient number of quadrupeds have been studied to leave no doubt that all quadrupeds produce eggs as well as birds, as well as all other animals, without exception. One of the ablest physiologists of our time, Professor Bischoff, of Munich, has devoted over twenty years of his life to the study of a few of these animals, and the results of his investigations are embodied in a volume of many hundreds of pages, with a large number of plates, representing the history of only four species of quadrupeds. One is the rabbit, another is the dog, a third is the guinea-pig, and the fourth a species of deer which is common in the forests of Europe,—the roebuck; and the history of these animals, as presented in this volume, covers only the very earliest period of gestation,—and mainly that portion of their history embraced during the first days of gestation, during the time when the egg of these animals is transformed into a germ which grows to be an animal like the parent. Now, unless we can have a similar history of any one of our more valuable domesticated animals, as of the horse, or of the cow, we cannot expect to know how to influence their reproduction. This is the very foundation of all knowledge in that direction. What will be necessary for that? When these investigations began they were made upon animals which could be secured at the lowest price; they were begun with the hen. Two

young German physiologists, Pander and D'Alton, under the guidance of Professor Döllinger, began that study, and, in order to ascertain how the chick is formed, — not how the chick grows in the egg, but how it is formed during the first hours after the sitting of the hen upon the egg has begun, — they opened three thousand eggs. Now, why is it that we have not yet such knowledge of the horse? Because there are not three thousand mares to be sacrificed to study their development; and unless some means are found by which something of the kind can be done, we cannot have the beginning of the history of that one animal; unless, perhaps, with the greater knowledge we now possess and long acquired skill, a smaller number of individuals may suffice; but not until hundreds and hundreds of animals are sacrificed for that purpose, under proper conditions, can we have the first fact concerning their history. And if you find in physiological text-books this subject treated as if it were entirely known, it is simply because the data in reference to the animals, the physiology of which is given in our text-books, are borrowed from the four animals carefully studied by Bischoff, and not from any particular knowledge obtained from the domesticated animals themselves. When, in our human physiology the embryology of the human race is presented, it is largely illustrated by conditions which have been studied from the rabbit, the dog, the guinea-pig and the roebuck. Direct observations are so few that they are hardly worth mentioning. A few cases of suicide have furnished the only information which is on record concerning the first condition of the human being.

And now I propose to show you what an egg is, and then to satisfy you that all animals produce such parts as deserve the name of egg.

A hen's egg, surrounded by its shell, which is calcareous, is lined on the interior by a double membrane. A skin extends over the whole internal surface, and that skin is double; and in one part of the shell it recedes from the shell and leaves an open space, which is the air-chamber of the egg. These are only protections of the egg, and are formed last upon it. In the interior of the egg we have a round ball of yolk which is suspended in the egg by two cords of somewhat harder albumen than that which surrounds the yolk. These two cords keep the yolk so suspended in the egg that whatever position you give the egg, certain parts

always remain uppermost. You may open any number of eggs and you will always find that a little white speck stares you in the face. You may turn the egg as you please, but that little speck will always be uppermost. This is owing to the fact that the yolk is heavier in one portion and lighter in another and that it may swing upon the two strings of albumen by which it is suspended. This speck, called blastoderm by embryologists, is the part from which the young chick is developed when the egg is brought under proper conditions of temperature, etc.

As to the albumen, or white, it is not one mass; it consists of a number of layers; and when you boil an egg so that the whole is hardened, it is easy to see that it peels off in these layers, which are deposited one after another. Now such an egg has a history. It does not begin to be an egg of that size; it does not begin with having a shell; it does not begin with having these membranes within the shell; it does not begin with having the white around the yolk. There is a time when the egg has neither shell, nor these membranes, nor the white, but when the whole egg is yolk; and you may find such eggs in the organ called the ovary, in which the eggs are produced. If we look carefully at the ovary of the hen, we find that it contains a variety of eggs. It has eggs which have attained to their full size—they are about the size of a small walnut—it may contain a certain number of these—but by the side of these large yolks there are smaller yolks of various dimensions, and if you will examine minutely, you will soon see that there are those, which, at the distance of a few feet, you could not see at all, even if I represented them magnified a great many times; and you gradually, by learning to watch more and more closely, detect among this mass of eggs which are readily visible, others which are less and less distinct to the eye; and if you take a magnifying glass, you find that there are others which had escaped your eye when you had no magnifying power to help you; and, if you use higher and higher power, you begin to find that there are more of these most minute eggs, which loom up to your eye in proportion as you use a higher power of the microscope. It is like the starry heavens, where you have stars of first, second, fourth and tenth magnitude, some of which are visible to the naked eye, and others only through the telescopes of our observatories. Yet all these small specks in the ovary, invisible to the naked eye, are *bona fide* eggs. As soon

as one of the full-grown yolks drops, to be taken up by the fallopian tubes and carried through the oviduct, there to be surrounded by albumen, and then by a shell, — another grows larger, and when all those which are at any moment of full size have been laid, they are followed by another crop, and crop after crop comes to the surface of the organ, ready to be laid in succession. If you watch their growth, it is easy to see that each one passes into the condition of the eggs higher in size by a process of increase which is similar to the process by which a young animal grows to acquire the dimensions of an adult. Nobody now doubts that these small granules scattered through the ovary are really eggs in their incipient condition.

How do they look when examined under the microscope, — say under a microscope magnifying two hundred and fifty times the diameter, — an egg, therefore, which could not be seen by any human eye? You magnify it, as I have said, two hundred and fifty times, and you will see that that egg is a sphere, which you may, with the microscope, magnify to look as large as a full-grown yolk. It is then perfectly transparent, as if it were full of a uniform fluid, like water; but at some places on the side it has a little vesicle, a little bag, which is also transparent, and may only be seen under skilful management; in this again there is still another microscopic body which appears like a small dot. Now you examine an egg a little larger than that, and you will perceive that in it the fluid mass is obscured slightly by small dots. If you apply the highest powers of the microscope to these dots, you very soon find that they are not solid granules, but that they are hollow vesicles which, in their turn, produce other granules within themselves, so that the growth of an egg is in fact the enlargement of little granule-like masses of animal substance, which are transformed into bag-like bodies within which the same process is repeated over and over again. As the whole egg grows larger, these little granules burst and scatter their contents into the surrounding fluid; and the egg, from perfectly white, becomes slightly tinged with yellow, and finally grows more and more opaque; and, when the yolk has acquired its full size and is ready to drop, it is really an opaque mass, but consisting throughout of these minute granules.

Now let us take the ovary of the rabbit, the guinea-pig, or any other quadruped, and examine its contents, and we see eggs ex-

actly like these young eggs of the hen; so similar to them, that the most skilful observer is incapable of distinguishing the one from the other,—the egg of a rabbit from that of a hen. Of course they do not remain in that condition. There is this peculiarity: that the egg of a quadruped remains small, and while retaining these small dimensions undergoes of itself changes by which the germ is developed in time: while, on the contrary, the egg of a bird grows large; even before it has its shell, its yolk becomes very large, and it is surrounded by those auxiliary means of protection necessary for an egg which is to be cast before the germ is formed; while the fecundated eggs of mammalia are not cast, and the young undergo their development in the egg while the latter is still retained by the parent. And so it has been proved by Baer, that there is no difference whatsoever between so-called viviparous and oviparous animals, but that all produce eggs which have the same identical structure, and which differ from one another only by their various capacities, by the various proportions which they attain, and by the various ways in which the germ is developed in them.

One more word to satisfy you that this is the case in all animals. Eggs of the larger birds have been observed as I have said, and it needs not to be repeated that in every species in which the observation has been carried on, it has been found that the ovarian egg,—that is, the egg prior to its being laid,—has the small dimensions and the peculiar structure characteristic of all ovarian eggs in their earliest condition. This is also the case with reptiles. Our little turtles lay eggs of considerable dimensions in comparison with their size; but examine their ovary, and you will find that there are contained in that organ eggs of all possible dimensions, as in the bird, and that when young these eggs do not differ from the egg of the quadruped. And so it is with the fish, whatever be the kind of fish. I have examined many sharks and skates, as well as many of our salmon and trout and our various kinds of suckers and codfish, and I know that all these different kinds of fish produce similar ovarian eggs. Some of them lay them early, and lay eggs which are at once recognized as eggs, and others retain their eggs until the young are fully developed and they bring forth then, like the quadruped, living young; so that they exhibit within the limits of one and the same class differences similar to those which we observe among

different classes in the higher animals. And if we pass from the class of fishes to the lower types of the animal kingdom, — to insects, for instance, crustacea, and worms, — we find everywhere the same process. Even the parasitic intestinal worms are now known to be produced by eggs, and eggs which are transferred by various processes from one animal to another, sometimes with their food or drink, at other times by boring into the body of their host, thus remaining parasites in succeeding generations. The same thing has been observed among the various kinds of mollusks, — the cuttlefish and periwinkles, the oysters, mussels, etc., for all these produce eggs; and when the eggs are examined, at the proper time, and in a proper manner, they exhibit exactly the same structure as those of the higher classes; and we may go down to the very lowest classes of the animal kingdom — the seaurchins, the starfish, the jellyfish, or even the corals or polypes, and there again eggs are found, and eggs which in no way differ from those of the higher animals.

From such statements, which cover now such extensive ground, it might be inferred that to know one is equal to knowing all. By no means; for enough has already been done to show us that every one has its peculiarities, every one has its own mode of development, and in every one there are peculiar processes which make the generalization only true in the most comprehensive form of expression, and no longer true in the details of the farther development. So that all our knowledge of the process of reproduction in one species of animals may not give us an answer when we would inquire into the corresponding process in another animal. Thus you see the necessity of repeating for those animals, the breeding of which we would desire to influence, all those observations which have been made upon a few.

I should like presently to make some remarks as to the kind of training necessary for this, that you may not imagine that the first enthusiast can go to work and do it. It requires a long training to be prepared to look at an egg, to be prepared to see how it grows; but before I make any such remarks, I would say a few words more concerning the formation of the germ, so that you may see what an interesting field of observation is now open to the student; *open*, not yet *cultivated;* by no means cultivated to the extent desirable in order to make the knowledge in any way useful in practical life. There is that condition necessary to

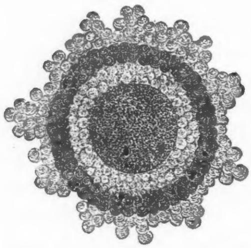
all knowledge, that it should be acquired, not only in its general features, in order to be useful, but that it should be brought to a point where it shall be really applicable to any practical purpose; and a great deal of the difficulty in scientific investigation arises from the fact, that while it is easy to study, to a certain extent, it is not always easy to carry our knowledge to the point where its application becomes easy or even practicable. And I would say, to exonerate science from its failure to make itself more generally popular and practical, that the mental qualities required for investigation are not the same as the qualities required for practical application. You know too much of practical life to need to be told that the importers who bring to your manufacturing establishments the raw materials are not those who make the cloth for your clothes; or that those who import the raw materials with which all the various manufactures are produced are not likely to be themselves manufacturers; and the ability of the one excludes very often the ability of the other. In scientific matters this is perhaps more extensively the case than in practical pursuits, so that a class of men must be educated who will take up knowledge where the scientific man leaves it, and carry it where the man of business, or the practical man, requires it. I could mention many a case in which scientific men have injured themselves in their attempts to derive profits from their scientific work or to apply their knowledge to practical purposes. That will happen again and again when scientific men rashly enter the arena of practical life. You must allow them to work in the field for which they were prepared, and accept from them what they can give. I claim that as due to science, and I think the sooner the community understands it the sooner will all have the benefit of what science can produce, and cease to ask the impossible from scientific men.

In this first presentation of the subject of embryology I shall not be able to give the whole history of the formation of a new being, but only so much of it as will satisfy you that our higher animals produce eggs like birds and the lower classes; but with this essential difference, that in mammalia the fecundated egg is not cast or laid, but undergoes all its changes within the maternal body until the living young is dropped. Here are several figures of ovarian eggs of the dog, rabbit and human female, which may easily be compared with the eggs seen in the ovary of a hen. Figures 154, 155, 156, 157, 158, 159, 160 and 161 are such ovarian eggs.

Figures 154, 155, 156, 157, 158, 159 and 160 show that the eggs of different mammalia, such as rabbits and dogs, resemble one another as much as the eggs of different species of birds belonging to different orders of this class.

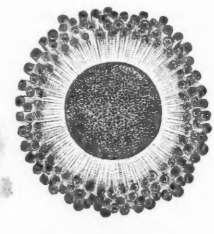
The formation of a germ in the egg begins by a very peculiar process, called "segmentation." It is unquestionably a manifestation of the internal life of the egg,—for an egg must be

Fig. 154.



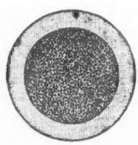
Ovarian egg of dog. Copied from Bischoff's embryology of the dog. Magnified 100 diameters.

Fig. 155.



Another ovarian egg of dog, from a female in heat. Copied from Bischoff. Magnified 100 times.

Fig. 156.



Ovarian egg of dog, freed of the cells which surround the zona pellucida in figs. 154 and 155. Copied from Bischoff. Magnified 100 diameters.

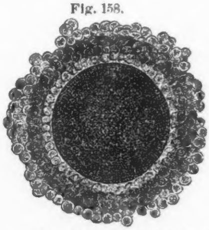
Fig. 157.

The same ovarian egg as that represented in fig. 156, cut open with a sharp needle. The mass escaping is *yolk*, with the transparent *germinative vesicle*, in which the *germinative dot* is visible. Copied from Bischoff. Magnified 100 times.

considered as a living body. Segmentation consists in this. Supposing we have here the egg of a dog, copied from Bischoff (fig. 162): the egg divides itself spontaneously into two halves (fig. 163), which are entirely independent of one another, and only retained together by the common envelope of the yolk. After that, each half divides itself into two halves again, so that the yolk

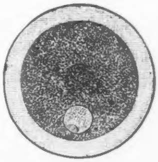
consists now of four masses of equal dimensions (fig. 164); and so the process goes on. Each quarter of the yolk divides itself again into halves, so that we next have eight such bodies (fig.

Fig. 158.



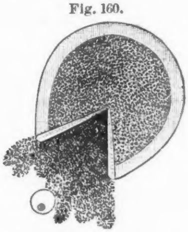
Ovarian egg of rabbit. Copied from Bischoff's embryology of the rabbit. Magnified 125 diameters.

Fig. 159.



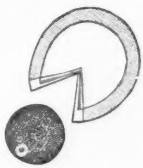
Ovarian egg of rabbit, freed of the cells which surround the zona pellucida in fig. 158. Copied from Bischoff. Magnified 125 times. The *germinative vesicle* shines through the *yolk* as a light spot.

Fig. 160.



The same ovarian egg of the rabbit as in fig. 159, opened with a needle. The yolk, with the germinative vesicle and dot are flowing out. Copied from Bischoff. Magnified 125 times.

Fig. 161.

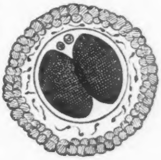


Ovarian egg of a human female, cut open. The yolk has escaped whole, and in it the germinative vesicle and germinative dot are seen as a lighter spot. Copied from Bischoff. Magnified 100 times. The resemblance to the eggs of the rabbit and dog, represented in figs. 157 and 160, is very striking.

165); first, irregular in shape, but very soon assuming the form of spheres, which fill the cavity of the yolk-membrane. Eight balls, as it were, resulting by spontaneous division in the formation of a mulberry-like body as is represented in fig. 165; and this is divided again, until the eight have become sixteen (figs. 166 and 167), the sixteen thirty-two (fig. 168), the thirty-two sixty-four, and so on until the whole of that mass is separated into little granules which are about as small as the primitive cells of which the yolk consisted (fig 169). We have then a

Fig. 162.

Fig. 163.



well-kneaded yolk-mass very similar to what the primitive cell was, only that, instead of simple yolk-cells, it now consists of an innumerable quantity of little spheres which have resulted from the spontaneous division of the whole into successively multiplied halves. There is, however, this difference,—that on one side of the egg there is, when this process is completed, a larger number

Fig. 164.

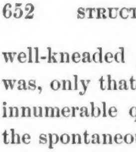
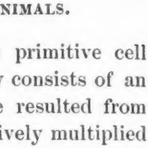


Fig. 165.



of these small balls or globules than on the other, and they are more whitish. The difference arises from the fact that the balls multiply more on one side than on the other. In quadrupeds this process of self-division pervades the whole yolk, so that in the centre and on the periphery, and on all sides, it is evenly divided, except that on one side the spheres are somewhat smaller and also somewhat more whitish. In the yolk of a hen

Fig. 166.

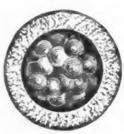


Fig. 167.

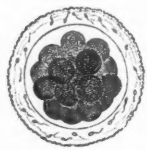
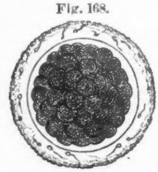
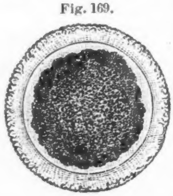


Fig. 168.



the process is widely different, and has been known only for a comparatively short time, for in the hen the process also takes place before the egg is laid. In order to examine it, therefore,

Fig. 169.



a hen must be killed and the egg must be observed during its passage through the oviduct, when on the surface of the yolk, and on the surface only, furrows are marked as if made with a nail. These furrows are multiplied crosswise, and then crosswise again, and this process is repeated until the whole surface is changed into these same globular bodies, already noticed in the rabbit and dog, but which in the hen extend only over a small part of the surface of the yolk. Now this small part of the surface of the yolk is that white speck which is seen at once when you open the shell of an egg; and from it the chicken is developed. In fishes, there is still another process. Suppose we take the salmon. The first segmentation of the yolk consists in halving

and quartering, and then the process of self-division goes on only in one-half, viz., in the upper half of the yolk, the lower half undergoing no change, so that you have at first only two spheres, one below and one above, then two in the upper part, then four in the upper part, then eight in the upper part, then sixteen in the upper part, the lower part remaining in its primitive condition, and the whole upper part finally being transformed into a body similar to what we have as a whole in the mammal, resting as it were on a cup of unaltered, unchanged yolk in the lower part. In the fish, it is this mulberry-like, segmented portion of the yolk which is changed into the germ, while the other half takes no part in the formation of the germ, but only feeds it, being in fact absorbed into it. The egg is actually a live being, only it is a live being which struggles into its structure by its own activity; and in the formation of the organs it afterward possesses, the process of growth is not one of enlargement simply, but involves such changes as to transform a uniform mass into a variety of systems built of different tissues and endowed with special functions. In the chicken, two parallel swellings first arise along the middle line of the back, leaving a shallow furrow between themselves; and the white disk, spoken of above as a white speck, enlarges and spreads so as to cover the whole surface of the yolk visible from above. If you look at this furrow in a section it will be something like an arch, open above. Gradually this furrow grows wider at one end, with indentations right and left, and then the margins of the disk spread, and, folding downward, enclose more and more of the yolk, and the sides of the furrow thicken, so that represented in profile it will be no longer a shallow furrow, but something like a channel or tube.

At this stage the whole mass has still about the same consistency everywhere. It is like soft jelly and a little pulpy, but presently the two edges of the furrow come more closely together, and finally touch. Meanwhile the margins of the new being rise in a fold and enclose the central parts, forming a sac around the germ, known as the amnios. The natural result of the closing of the upturned edges of the germ is the formation of a cavity, enclosed between these edges. That cavity now fills with a transparent fluid, and as it fills there appears something a little more substantial upon its sides and below it; the walls protecting the cavity become less transparent or even slightly opaque; then the cavity

widens sidewise on its anterior part, and rises a little from the rest. In one word, this cavity forms the channel for the spinal marrow, and its front part the cavity for the brain, and the walls grow to be flesh and bone to form the dorsal spine. The upper part represents the axis of the skeleton, with the surrounding soft parts: the lateral parts form the ribs with their fleshy covering, and, the animal thus closing over the yolk, we have the abdominal cavity. Now, it requires a little more enlargement, a little more change into different substances, to complete the formation of the new being. The gelatinous substance outside the main axis is changed into a fibrous structure, which is muscle. The little opaque bodies in the axis and upon its sides absorb some earthy material contained in the primitive substance from which they have arisen, and thus bone is formed. The fluid in the upper cavity becomes a little more granular and more solid, and it is the brain and spinal marrow. The yolk is absorbed during the process of growth, but the wall within which it is contained is elongated and enlarged, and in consequence of farther changes in the substance of that part of the yolk which is in immediate contact with the body-walls, the alimentary cavity is formed. You have, in fact, all the organs of the animal growing in the same way, by successive transformations of the homogeneous mass into all the various tissues and organs which build up the animal in its perfect condition.

From the time the chick has reached the condition in which all its organs are fairly sketched, it simply grows larger and larger, and finally breaks through the shell. The skin has already become distinct from the muscles; the feathers begin to be formed, and all those parts with which you are familiar may readily be distinguished. You see now by what complicated process (the details of which I have considerably abridged) this is brought about.

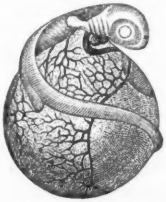
I have given you but a meagre outline of the changes which take place in the formation of quadrupeds, birds, reptiles, and fishes, though this may be sufficient to show that these processes must be studied in every animal independently.

The figures on the following page, representing a fish in the egg, show at once how different the growth of these animals is from that of the mammalia and birds. Here we have no amnios; the young fish remains free upon the surface of the yolk. The structure of the body, however, and the circulation of the blood upon the yolk, are strikingly similar to those of the dog, the

chicken, or the little turtle. Compare in this respect the figures of D'Alton with those of Bischoff and my own in the embryology of our terrapene.

Now, what are the conditions necessary for making these observations? A man must be practised, and not only practised, but fully skilled in the use of the microscope. He must know the structure of the animal in its adult condition so accurately, and so completely, that every difference in the structure of the younger animal will at once strike his eye. He must be able to make these comparisons without having specimens before him for comparison;

Fig. 170.

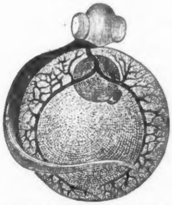


Young Blenny, copied from Rathke's Embryology of the *Zoarces viviparus*. Magnified. Seen in profile from the right side.

Fig. 171.

The same as fig. 170, seen in profile from the left side.

Fig. 172.



The same as figs. 170 and 171, seen in front.

Fig. 173.

The same as figs. 170, 171 and 172 before the egg-shell has burst.

he must have appropriated that knowledge to himself so completely that he may weigh the changes going on in the substance of the germ, merely by the eye, and ascertain every change in so accurate a manner that he may record the facts in their true connection. And more than that, he must be able to prepare the conditions in which these germs will not be altered by being brought under the microscope. Try to bring an embryo, a young chick, in that early stage of growth, as you see it after a few days' incubation, under the microscope, and you are likely to find

that you have reduced it to a shapeless mass. These objects cannot be handled like a piece of wood. They must be treated with a degree of delicacy which makes it impossible, for instance, for an observer to use any stimulant, even such as coffee and tea, or to eat heartily, or to exercise in any degree which may accelerate the pulse; otherwise his eye will be constantly thrown out of focus. Unless a man has himself under control to that extent, he cannot begin to make good observations. Not only must he have the knowledge necessary, not only must he have the practice necessary, not only must he have the instruments necessary — he must have his own organization so completely under control that he brings himself into that living relation with the object of his observations which alone makes it possible that they shall be accurate. It is not everybody who is willing or able to do this; and then he must carry on his observations by day and night, as the embryo is growing unceasingly, and unless he does continue his observations uninterruptedly, he may miss the most important steps in the progress of growth. Now before you find a man qualified to be an observer, you may have to wait a long while. It was just so during our late war. We did not find the generals who knew how to command, the day of the first battle. It requires years to find a man capable of leading two hundred thousand men. In matters of scientific progress we need a great many students, and large schools, from which to pick out the man who is capable of making new discoveries, or simply accurate investigations; and have we these schools now? Is the number of our scientific students proportionate to the intellectual capacity of the nation? By no means; and until our system of popular education is radically changed, or so far changed, at least, that in all our schools instruction is given in those branches of science which train observers, you may not even have the knowledge necessary to carry on your practical pursuits, and still less the chances of making any real progress. These results can only be brought about by introducing into our schools that sort of instruction which prepares students to become observers, or at least, which gives the teacher an opportunity of ascertaining whether any of his pupils may be educated into an observer or not. Such schools we have not, such teachers we have not, or very few of them — half a dozen in Massachusetts is the sum-total of men qualified to teach in that way; and the schools in which they may teach, the apparatus necessary for that

instruction, we have not. We have to build them up, and we shall not have them before the community understands what are the conditions necessary for the acquisition of new knowledge which may improve the conditions of our success in the practical affairs of a civilized community.

You may ask what text-books you shall take to begin with. There are none that I would recommend. You cannot use the present text-books, for most of them are manufactured by people who know nothing or precious little of the subject about which they write. They are mere compilations, made for the market, by men who have no sort of knowledge of what should be the substance of a text-book; and, what is worse than that, our schools are crowded with so large a number of pupils that the teachers, even the very best of them, have to resort to all sorts of devices in order to keep alive. Instead of teaching, that is, instead of giving out of their knowledge and their substance something by which they can vivify the intellect of their pupils, they are forced by the pressure of numbers to direct their pupils to commit to memory some superannuated book, and to make them recite things not worth knowing. So there we must begin. We must begin by relieving the teacher from a task to which no human being is equal; for it is impossible for any one person to teach eighty pupils well, in one and the same room, at the same time, and to teach every branch of human knowledge in close succession. It is physically impossible. It is past endurance; and all those who have tried to do this kind of work, honestly and faithfully, have paid for the effort with the loss of health. And then there is another point. In order to get men capable of performing the difficult task of teaching, you must give greater inducements to able intellects to devote themselves to the task. The teacher's profession must not be the least remunerative of any profession in the community, as at present it is. Only those who by nature cannot help being teachers go into it, and their willingness to teach is misused by the community by giving them a pittance for their existence. So one more thing is needed: you must organize normal schools to educate teachers of natural history and science generally. You must not only determine that you will introduce these branches of knowledge into your schools, but you must prepare teachers for the task.

ON STAUROLITE CRYSTALS AND GREEN MOUNTAIN GNEISSES OF THE SILURIAN AGE.*

BY PROF. J. D. DANA.

IN a paper published in the "American Journal of Science" in 1872 I mentioned the fact, first noticed by Percival, that crystals of staurolite are found in Salisbury, Connecticut, in mica schist "underlying" directly the Stockbridge or Canaan limestone. Since then I have found in southern Canaan, at a locality in Falls Village, west of the Housatonic River (to which I was directed by Dr. Stephen Reed of Pittsfield), crystals of this mineral in a very similar, well-characterized mica schist; but in this case, the schist *overlies* the limestone and is, therefore, the newer rock.† This staurolitic mica schist contains also small garnets. The order of superposition is free from all doubt, for the Canaan limestone outcrops at the bottom of the same hill, from beneath the schist, and the dip is not over fifteen degrees.

The age of the Stockbridge limestone is admitted by all recent writers on the subject to be Lower Silurian. Logan referred it to the Quebec group or the formation next below the Chazy. But since then Billings has described fossils from the same limestone at West Rutland, which he has identified as Chazy. And the Crinoids and other species, mentioned in the "Vermont Geological Report" as found in the limestone at other Vermont localities appear to show, as long since suggested by Professor James Hall, that the Trenton limestone is also present in the formations. The Chazy and Trenton limestones (Black River included) follow one another in New York, and the west and south. That the Canaan limestone is the same identical stratum that occurs at Stockbridge in Massachusetts, and farther north at Pittsfield, I know from a personal tracing of the rock throughout this region; and examinations still farther north in Massachusetts and Connecticut lead me to believe in the conclusion of the geologists of the Vermont survey, that all is one formation—the Stockbridge limestone, or the Eolian as Hitchcock named it.

* Read at the Portland Meeting of the Amer. Assoc. Adv. Sci.

† From facts I have observed elsewhere, I think it probable the Salisbury schist is also an *overlying* rock.

The fossils found in Vermont lead to the conclusion that the limestone represents the Trenton era as well as the Chazy. The overlying mica schist and other associated rocks have a thickness of at least three thousand feet; and, if the limestone is Trenton in part, they belong to an era later: either to a closing part of the Trenton period, or to the period of the Hudson River or Cincinnati group.

In any case there is no reason to doubt that the staurolites occur in rocks of the later part of the Lower Silurian age, and strong reason for the conclusion that these schists are in age veritable Hudson River rocks.

On this view, the Hudson River or Cincinnati group, in the Green Mountains — alike in Connecticut, Massachusetts and Vermont, — includes beds of quartzite, mica schist, chloritic mica slate, hydro-mica slate (the talcose slate of the earlier geologists), well-characterized gneiss of various kinds, some of it much contorted, and granitoid gneiss.

At a locality at South Canaan village, in Cobble Hill, the lowest rock over the limestone is quartzite; next follows mica schist passing into gneiss; and above this there is a light-colored granitoid gneiss, breaking into huge blocks with very little of a schistose structure.

Near the boundary of the towns of Tyringham and Great Barrington, four miles east of the latter village, a locality long since studied by Mr. R. P. Stevens of New York, and by him pointed out to me, there are, over the limestone, alternating beds of quartzite gneiss and limestone dipping at a small angle to the eastward. Commencing below, the succession is

1. Granular limestone, that of the valley.
2. Mica schist, a thin bed.
3. Hard jointed quartzite, 30 feet.
4. White granular limestone, 60 feet.
5. Hard jointed quartzite, 20 feet.
6. Gneissoid mica schist, 30 feet.
7. Bluish granular limestone, 40 feet.
8. Mica schist, 6 to 8 feet.
9. Quartzite, partly laminated, 120 feet, forming a high bluff,—the site of Devany's hearthstone quarry; and then
10. Gneiss, forming the top of the bluff, and having great thickness in a ridge to the northeast, but in its upper portions becoming very silicious or in part quartzite.

The fact that quartzite, limestone and gneiss or mica schist here alternate with one another is beyond question; and, if I am right in the age of the deposits above suggested, the alter-

nations occur at the junction of the Trenton and Hudson River formations.

The above section occurs on the east side of a small open valley. On the west side of the same valley the foot of the bare front of the hill consists of quartzite, dipping slightly to the north-westward, as if one side of a very gentle anticlinal of which the rock of the Devany quarry is the opposite. The quartzite, although hard and generally pure, contains a layer of mica schist ten inches thick which becomes pure quartzite a hundred feet to the eastward. Above the quartzite follows gneiss, which continues westward three miles, in a shallow synclinal, to Great Barrington, and there this gneiss is overlaid by a second thick stratum (100 feet or so) of quartzite. Here, then, there are two strata of quartzite separated by two or three hundred feet of gneiss, the whole overlying the Stockbridge limestone. The gneiss is a very firm rock, covering the slopes in some places with blocks like houses in size, where upturned through the growth of trees. I had suspected that it was one of the older gneisses of New England, until I found that it was overlaid by quartzite, and, on tracing further the stratification, proved that it belongs unquestionably to the series of rocks newer than the limestone.

From the facts which have been presented it follows that all old-looking Green Mountain gneisses are not præ-silurian, and, further, that the presence of staurolite is no evidence of a præsilurian age.

NOTE ON BUFO AMERICANUS.*

BY REV. DR. THOMAS HILL.

This note is intended as a contribution toward the psychology of the American toad; simply presenting some evidences of intelligence and of capacity for learning to which I have been witness.

In the summers of 1843–5, an old toad used to sit under the door of a beehive every fine evening, and dextrously pick up those bees which, overladen or tired, missed the doorstep and fell to the

*Read at the Portland Meeting of the Amer. Assoc. Adv. Sci.

ground. He lost, by some accident, one eye, and it was observed by several members of the family, as well as myself, that he had with it lost his ability to pick up a bee at the first trial; his tongue struck the ground on one side the bee: but after several weeks' practice with one eye he regained his old certainty of aim.

I have never seen our toad use his hands to crowd his food into his mouth as the European toad is said to do; although he uses them freely to wipe out of his mouth any inedible or disagreeable substance. When our toad gets into his mouth part of an insect too large for his tongue to thrust down his throat (and I have known of their attempting full grown larvæ of *Sphinx quinquemaculatus*, and even a wounded hummingbird) he resorts to the nearest stone or clod and presses the protruding part of his mouthful against it and thus crowds it down his throat. This can be observed at any time by entangling a locust's hind legs together and throwing it before a small toad.

On one occasion I gave a "yellow-striped" locust to a little toad in its second summer, when he was in the middle of a very wide gravel walk. In a moment he had the locust's head down his throat, its hinder parts protruding; and looked around for a stone or clod, but finding none at hand, in either direction, he bowed his head, and crept along, pushing the locust against the ground. But the angle with the ground was too small and my walk too well rolled. To increase the angle he straightened his hind legs up, but in vain. At length he threw up his hind quarters, and actually stood on his head, or rather on the locust sticking out of his mouth,—and after repeating this once or twice succeeded in "getting himself outside of his dinner."

But these instances of ingenious adaptation to the circumstances, were exceeded by a toad about four years old at Antioch college. I was tossing him earth worms while digging, and presently threw him so large a specimen that he was obliged to attack one end only. That end was instantly transferred to his stomach, the other end writhed free in air, and coiled about the toad's head. He waited till its writhings gave him a chance, swallowed half an inch, then taking a nip with his jaws, waited for a chance to draw in another half-inch. But there were so many half-inches to dispose of that at length his jaws grew tired, lost their firmness of grip, and the worm crawled out five-eighths of an inch, between each half-inch swallowing. The toad, perceiving this, brought his

right hind foot to aid his jaws, grasping his abdomen with his foot, and, by a little effort, getting hold of the worm in his stomach from the outside; he thus by his foot held fast to what he gained by each swallow, and presently succeeded in getting the worm entirely down.

A garter-snake was observed this summer in North Conway pushing a toad down his throat by running it against clods and stones; just as the toad crowds down a locust.

The amount which a toad can eat is surprising. One Tuesday morning I threw a *Coreus tristis* to a young toad, he snapped it up, but immediately rejected it, wiped his mouth with great energy, and then hopped away with extraordinary rapidity. I was so much amused that I gathered some more of the same bug and carried them to a favorite old toad at the northeast corner of my house. He ate them all without making any wry faces. I gathered all that I could find on my vines, and he ate them all, to the number of twenty-three. I then brought him some larvæ of *Pygœra ministra*, three-quarters grown, and succeeded in enticing him to put ninety-four of them on top of his squash bugs. Finding that his virtue was not proof against the caterpillars when I put them on the end of a straw and tickled his nose with them, he at length turned and crept under the piazza, where he remained until Friday afternoon, digesting his feast.

A gentleman having read this paper told me he had seen the toad tuck in the last inch of an earth worm with his hand, European fashion. I then remembered that I have several times seen our toad put the last quarter-inch of earthworms in with his hand; but never saw him take his hand to a locust.

ON SECTION *AVICULARIA* OF THE GENUS *POLYGONUM.*

BY SERENO WATSON.

MEISNER'S *Polygonum* §*Avicularia* is equivalent nearly to section *Polygonum* of Linnæus, the original genus *Polygonum* of Tournefort and Adanson, to which Linnæus added, as coördinate sections, *Persicaria*, *Bistorta* and some other old genera. Its most dis-

tinctive characteristics are the leaf jointed upon the petiole at the point of divergence from the sheath; the broadly dilated filaments of the three inner stamens; and the incumbent cotyledons. Of these the first occurs in no other section of the genus, excepting § *Tephis*, of a single species, but is found in *Atraphaxis*, *Thysanella* and *Polygonella*, of the subtribe *Rumiceæ*. The second is also peculiar to § *Tephis*, but exists in *Atraphaxis* and a section of *Polygonella;* while the third, occurring besides only in § *Amblygonon* of *Polygonum*, is characteristic of *Rumex*, *Atraphaxis*, *Thysanella* and some species of *Polygonella*. The closest affinity of the section is to the genus *Atraphaxis*, which has also perfect flowers and the same peculiar stipular sheaths, and from which it is distinguished mainly by its more or less herbaceous sepals not enlarging or deflexed in fruit but appressed to the achenium. It would seem that the genus *Polygonum* should be restricted to the two sections *Avicularia* and *Tephis*, on account of this, in these respects, nearer relationship to the *Rumiceæ* than to the other sections with which they are at present united.

The species *P. articulatum*, which was long retained in § *Avicularia*, but referred by Meisner to *Polygonella*, and restored by Dr. Gray to *Polygonum* as § *Pseudo-polygonella*, must be placed with *Polygonella ericoides* (which includes *P. Meisneriana*), having a similarly excentric embryo, somewhat contorted, and the cotyledons either accumbent or incumbent. Its scarcely dilating inner sepals are those of *Polygonella polygama* (*P. parvifolia*), and its colored marcescent calyx, the solitary flowers upon elongated pedicels jointed near the middle, and the peculiar floral sheaths, are common to all the species of *Polygonella* in contradistinction to those of *Polygonum*.

The section *Avicularia* and the North American species belonging to it may be defined and arranged as follows:—

§ AVICULARIA, Meisn. Calyx more or less herbaceous, at length connivent upon the achenium, 5- or rarely 6- parted; stamens 5-8, sometimes but 3, the filaments opposite to the inner sepals broadly dilated; achenium 3-angled; albumen horny; embryo lateral with incumbent cotyledons. Herbaceous, or somewhat woody at base, never climbing nor aquatic; leaves jointed upon the short petiole; stipules hyaline at least above the sheath, the lateral lobes entire or bifid, at length lacerate; flowers axillary or apparently spicate by the abortion of the floral leaves, cymosely fascicled in the sheaths or rarely solitary, the pedicels jointed to the short base of the calyx; bractlets hyaline.

* Smooth perennials (*P. maritimum* sometimes annual), the chestnut-brown stems somewhat woody at base, the slender branches leafy to the top; leaves thick; stipules conspicuous; calyx mostly colored, rather large and open, exceeding the lanceolate smooth achenium and loosely appressed to it; stamens 8.

1. P. BOLANDERI, Brewer, *Proc. Amer. Acad.*, viii, 400. — Stems erect, very slender, 6–15′ high, nearly naked, with short simple densely leafy branches above; leaves narrowly linear, 2–4″ long, often cuspidate; stipules about equalling the leaves, finely lacerate; flowers mostly solitary, $1\frac{1}{2}$″ long, light rose-color; styles half as long as the ovary.— Sacramento Valley, California.

2. P. SHASTENSE, Brewer, *l. c.*— Prostrate or ascending, the branches 2-6′ long, usually naked; joints very short; the lacerate lobes of the stipules mostly deciduous from the herbaceous sheath; leaves oblanceolate, 4–6″ long, often folded, not revolute; flowers 1–3 in the lower axils of the leaves, which crowd the ends of the branches, deep rose-color, $1\frac{1}{2}$–$2\frac{1}{2}$″ long on exserted pedicels; styles much shorter than the ovary.— In the Sierra Nevada, California.

3. P. PARONYCHIA, Cham. and Schlecht.— Prostrate, the branching stems 1–3° long; leaves linear-lanceolate, $\frac{1}{2}$–1′ long, acute, the margins revolute; flowers densely crowded at the ends of the branches, rose-color, 3″ long; styles as long as the ovary. — On the seacoast from San Francisco to Puget Sound.

4. P. MARITIMUM, L.— Prostrate, glaucous, stems $\frac{1}{2}$–$1\frac{1}{2}$° long, very shortly jointed; leaves oval to linear-oblong, 3–10″ long; flowers 1–$1\frac{1}{2}$″ long, on mostly exserted pedicels; achenium equalling or slightly exceeding the sepals.— On the seacoast from Massachusetts to Georgia; usually annual in the more northern localities; not distinguishable from the Old World species.

* * Annuals, with striate stems leafy throughout; calyx colored upon the margins, becoming closely appressed; styles short.

5. P. AVICULARE, L. — Mostly prostrate or ascending, glabrous, bluish-green, the branches slender and elongated; leaves oblong to lanceolate, 3–10″ long, usually acute or acutish; flowers rarely 1″ long, pinkish-white, the pedicels not exserted, stamens 8 or rarely 5; achenium broadly ovate, 1″ long or less, dull and minutely granular. — Common about yards and roadsides; probably not indigenous.

6. P. ERECTUM, L.— Stouter, erect or ascending, glabrous, 1–2° high or more, yellowish; leaves oblong or oval, $\frac{1}{2}$–$2\frac{1}{2}$′ long, usually obtuse; flowers mostly $1\frac{1}{2}$″ long, often yellowish, on more or less exserted pedicels; sepals rarely 6; stamens 5–6; achenium broadly ovate to lanceolate, dull and granular or nearly smooth.— From the Eastern States and Canada to Nevada and Oregon; a strictly American form.

7. P. MINIMUM, Watson, *King's Rep.*, v, 315.— Somewhat scabrous-puberulent; stems very slender, decumbent or ascending, 6–15′ long (or an alpine form, very dwarf), brownish and often flexuous; leaves ovate to lanceolate, 2–8″ long, acute at each end and sometimes cuspidate; flowers in all the axils, 1″ long or usually less, light rose-color, on very slender exserted pedicels; stamens [illegible]; styles short; achenium smooth and shining, exceeding the calyx.—In Oregon (Pickering, 452 Hall), and in the Wahsatch and Uintas at 9–11,000 feet altitude.

8. P. TORREYI.— Closely resembling the last, but perfectly smooth; the flowers mostly near the ends of the branches and nearly sessile in the axils of the crowded leaves; stamens 6; achenium considerably exceeding the calyx. — Collected by Dr. Torrey in the Yosemite valley.

* * * Annuals with striate stems, the branches slender and virgate, angular; leaves diminishing upward and becoming bractlike, the spikelike inflorescence more or less interrupted.

9. P. RAMOSISSIMUM, Michx.— Erect or ascending, 2–4° high, glabrous, yellowish; leaves lanceolate to linear, 1–$2\frac{1}{2}$′ long, acute; flowers and achenium as in *P. erectum*, but the sepals more frequently 6, the stamens 3–6, and the achenium mostly smooth and shining. — From the northern Atlantic States to the Saskatchewan and the Pacific.

10. P. TENUE, Michx.—Erect, $\frac{1}{2}$–$1\frac{1}{2}$° high, glabrous or rarely slightly scabrous at the nodes; leaves linear to lanceolate, 1–2′ long, acute at each end and often cuspidate, obscurely 3-nerved; flowers often solitary, 1–2″ long, deflexed in fruit, the sepals margined with white or pink; stamens 8; styles much shorter than the ovary; achenium ovate, black and shining.— From Canada to the Carolinas and west to Oregon. Var. LATIFOLIUM, Engelm., has broader leaves and more numerous flowers; Var. MICROSPERMUM, Engelm., is a low slender form, with minute flowers and fruit, perhaps distinct; both occur in the Rocky Mountains.

11. P. CAMPORUM, Meisn.— Smooth, erect or ascending, 2-3° high, the branches short-jointed and branchlets mostly terete; leaves linear-lanceolate, 1-2' long, acute, or sometimes oblong, but ½' long and obtuse; bracts hardly exceeding the flowers; pedicels slender, exserted from the short sheaths; sepals colored, ¾-1'' long; stamens 8; styles nearly equalling or at least half as long as the achenium; fruit less deflexed than in the last.— Texas to Kansas. Meisner was mistaken in classing this with the perennial species, and perhaps also in referring to it the South American var. *australe*.

12. P. COARCTATUM, Dougl. — Resembling *P. tenue*, but scabrous-puberulent, the stems often brown; leaves linear, acute, 1-nerved; spike usually rather dense; calyx more petaloid and conspicuous, 1-2'' long; styles as long as the ovary.— From Puget Sound and central Idaho to the Sacramento.

* * * * Low slender annuals, the spikes short and dense, and the bracts imbricated; sepals colored.

13. P. POLYGALOIDES, Meisn.—Stems 2-6' high, smooth, branching; leaves narrowly linear, ½-1' long, acute; spikes dense, 3-8'' long, the bracts closely imbricated, 2'' long, oblong to nearly orbicular, with broad scarious margins, mostly obtuse; stipules lanceolate, entire or lacerate; sepals 1'' long or less; stamens 8; styles as long the ovary; achenium ¾'' long, minutely tuberculate-striate or smoothish.—Collected only by Spalding and Pickering, in Oregon and central Idaho.

14. P. IMBRICATUM, Nutt., in herb.— Resembling the last; often diffusely branched, 1-8' high; bracts loosely imbricated, linear or oblong, 2-4'' long, with sometimes a narrow scarious margin, acute; stamens 3 or 5; styles one-third as long as the ovary. —Frequent in the mountains, alpine and sub-alpine, from Colorado to Oregon and northern California. It has usually been considered a form of *P. coarctatum*.

Meisner refers also to this section his *P. Californicum*, founded upon 1944 Hartweg, without fruit. It is separated, however, by every character but habit, and the remarkable peculiarities of the achenium require that it should be placed in a distinct section, not very closely allied to any other in the genus, as follows:—

§ DURAVIA. Sepals 5, colored, becoming somewhat appressed to the achenium; stamens 8, the three inner filaments but slightly dilated at base; styles 3, the stigmas capitate; achenium membranous, linear, nearly terete, obscurely 3-angled; embryo lateral; cotyledons accumbent; flowers in slender many-jointed interrupted spikes, mostly solitary and nearly sessile in the sheaths; the scarious stipules not lobed, finely lacerate; leaves linear, not jointed upon the petiole.

1. P. CALIFORNICUM, Meisn.—Annual, erect, very slender, 3-6' high, minutely scabrous-puberulent, brownish, the branches mostly floriferous their entire length; leaves linear to filiform, 6-15'' long, cuspidate; bracts 1-2'' long, 3-nerved, but little exceeding the stipules; calyx 1'' long, rose-color; styles much shorter than the ovary; achenium slightly exserted, the light-colored pericarp thinly membranous, rather closely enveloping the terete seed, with slightly raised angles; testa reddish.— On dry hills bordering Sacramento and Napa Valleys, California.

THE STRUCTURE OF THE SCALES OF LEPISMA SACCHARINA.

BY G. W. MOREHOUSE.

For many years this test has been subjected to most careful and critical examination by the most competent observers and with the best microscopes, but, after all, the true character of its markings still remains a disputed question. These differences of opinion have evidently arisen partly from the complex nature of the markings themselves, and partly from the different conditions under which they have been seen. In this scale we have coarse ribs easily seen with a very ordinary glass, and on the other hand delicate structures severely taxing the powers of the finest objectives in existence. This fact alone is sufficient to account for the want of agreement, without accusing any person of being biassed by a theory; while those observers who think their own instruments are the best will continue to be satisfied with what they may happen to see, and shut their eyes to any advance.

As the microscope has been improved, our ideas of the structure of the Lepisma scale have been gradually modified, and who will now claim it to be "too easy for a test object?"

In the order of difficulty of resolution we have—

1. The heavy longitudinal ridges running from end to end of the scale and slightly projecting at the point.

2. Distinct ribs generally radiating from the quill, or curved parallel with the outline of the scale, and becoming faint in the centre and parts remote from the quill.

3. Transverse corrugations of the membranes.

4. Faint irregular veins branching from the diverging ridges (No. 2) generally taking a transverse direction, and, together with the corrugation, causing the spurious appearance of fine beading at their points of intersection with the ridges.

To make sure of my work on this scale I have studied it under a number of different conditions. The observations have been conducted with monochromatic sunlight; with white cloud and lamp; with central beam and oblique; with mirror, prisms, achromatic condenser with and without central stops, and with Wen-

ham's paraboloid. All these methods point to the same conclusions. Following up the line of observations described by the late Richard Beck, in his most valuable contribution to our knowledge of this subject, the same results were arrived at in regard to the appearance of coarse beading, etc., viz., "that the interrupted appearance is produced by two sets of uninterrupted lines on different surfaces"* That the longitudinal and the oblique lines are on different sides of the scale is also plainly seen by their lying in different focal planes under a $\frac{1}{50}$ objective. And farther, while examining a scale in fluid I have repeatedly observed air bubbles on one surface of it confined by the longitudinal ribs, and on the other side others bounded by the oblique ridges; and on moving the slow adjustment up and down, with the movement of the bubbles under control, they never interfere or mix with each other.† Nothing further is required to prove that these markings are actually ridges and that they project from different surfaces of the object. The experiments of Mr. Beck settle this question.

As microscopical definition advanced the very feeble radiating lines were noticed in the spaces between the ribs, formerly thought to be smooth. In the central portion of the test these lines are parallel with the main ribbing. They in their turn were seen to be uneven and pronounced to be "beaded striæ."‡ Must this fine beading like its shadowy predecessors be also extinguished by intersecting cross lines and so add one more to the long list of illusory appearances? To attempt to throw some light upon this question is the principal object of the present article.

In the first place, it is far from being a difficult feat to see this beading. Any first class lens, from a $\frac{1}{5}$ upward, when properly handled, will display it or something very like it. The writer has found it an easy task with Wales' $\frac{1}{15}$ immersion, or even with a Beck $\frac{1}{5}$ and deep eye-piece. With Tolles' $\frac{1}{50}$ immersion the fine transverse structure indicated above is brought out, and it becomes at once evident that the small beads are indeed spurious like their big brothers, and for a similar reason.

The fine transverse markings seem to branch from the faint radiating ones and have the appearance of a net-work of minute capillaries. Beside these there are coarser transverse waves or

* The Achromatic Microscope, Beck, p. 50.

† See Micrographic Dictionary, 2d ed., p. 34, Fig. 3, pl. 27.

‡ See M. M. Journal, March, 1873, pl. xi, Figs. 3 and 4.

corrugations of the membrane. In numerous instances, air bubbles have been observed imprisoned between the heavy ribs on one or two sides, and by these corrugations on the other sides. Therefore the corrugations may safely be said to be on the same surface of the scale with the longitudinal ridges, and the branching vein-like structure on or near the other surface. Careful focussing is corroborative of this idea, making it certain that these two details of structure lie in different planes. With monochromatic light, the delineation of this structure is eminently satisfactory, and the effect of the slightest change in focal adjustment is at once felt. When the object is a little out of focus the light is unequally refracted and broken up in passing through this complicated network of ridges and corrugations, and produces an appearance of fine molecules over the whole surface of the scale.

The coarse and the fine beads both vanishing under advancing definition, together with the behavior of the confined bubbles of air, seems to my mind fully to demonstrate the reality of the structure above described. Often, when the corrections are not perfect, the semblance of beading can be directly traced to a seeming enlargement of points of linear intersection and branching. When the $\frac{1}{50}$ is at its best work the finer transverse markings are usually irregular both in strength and direction but always unmistakable. They may be plainly seen on some of the smaller scales and in the central parts of the larger, and at almost as good advantage as near the edges of the easier scales. Sometimes they are continuous across several intercostal spaces and again only extending across one, or it may be merely budding, as it were, from the ribs. It will be noticed that the "beads" as drawn by Mr. Hollich exhibit corresponding irregularities.

In conclusion the remark of Beck on the scales of Lepidocyrtus may well be quoted—"and my own belief is that the markings upon this and all other varieties of Podura-scales are more or less elevations or corrugations upon the surface, which answer the simple purpose of giving strength to very delicate membranes."* If this idea is true of the Podura it applies with greater force to the complicated ridges of Lepisma.

The same original structure is often modified in diverging directions so as to subserve totally distinct purposes. And as hairs are probably modified scales, and a regular gradation may be

* Transactions R. M. S., 1862, p. 83.

traced between them, so the connecting chain is filled up between ribs extending from end to end of a scale, through undulations and shorter ribs, to those slightly projecting, and so on to the perfect spine or secondary hair.

THE NORTH AMERICAN GOATSUCKERS.

BY DAVID SCOTT.

The whippoorwills and nighthawks of North America are by many confounded and considered to be the same species. This impression is, nevertheless, entirely erroneous ; and I hope to show, in the following remarks, such obvious differences existing between them as will convince the most superficial observers of their non-identity.

It is surprising that our farmers (for they perhaps are the persons by whom these birds are most generally confounded) should consider such widely separated species, which resemble each other in color only, the same. It exhibits a carelessness which is hardly excusable, for doubtless the majority of them have shot the birds in question, and a simple comparison would surely convince them of their error. That any supernatural ideas should be entertained respecting these harmless and useful birds appears even more surprising; but such is the case with a large number of people, more especially, however, with the uneducated. There is prevalent in various sections of the country a remarkable awe, not to say fear, of them: and various are the misfortunes which are ascribed to their supposed supernatural influence — such as the sudden death of one of the inmates of a house, which, it is affirmed, surely follows the song of the whippoorwill if he be perched upon the door-sill. It is also believed by some that the white spots on the wings of the nighthawks are silver dollars. The pertinacity with which superstitious traditions cling to people is well known, and the foregoing, which are not all that are current respecting these birds, form no exception. They have undoubtedly been handed down and preserved through many generations. It appears remarkable, but there seems to be something about these birds which has excited the superstition of various nations for

ages back. Their very name implies this. The appellation "goatsuckers," which has now extended to the whole family, was, without doubt, suggested by their very wide gape. This led to the idea entertained by the ancients that they sucked goats.

In the west these birds have been accused of the crime of sucking milk from cows—about as probable as snakes being guilty of the same offence; yet there are hundreds who believe in such impossibilities: and to this belief may be attributed the cause of their being birds of evil omen in the estimation of our rural population. These mistaken notions have been current since the days of Aristotle, if not still further back. Absurd as they may appear to an enlightened and reflecting person, they are, nevertheless, firmly believed by many, which may to a certain extent account for the universal ignorance of the birds as well as of their habits.

The main reason, however, that these birds are confounded is in reality due to the great dissimilarity in their habits; for the nighthawks are often seen, and only occasionally heard, while the whippoorwills are frequently heard and seldom seen: and their very similar appearance when asleep or resting for the day (the whippoorwills being seldom observed at any other time) tends also to confirm the opinion that they are the same species.

The family *Caprimulgidæ*, to which these birds belong, is divided into three sub-families, *Steatornithinæ*, *Podarginæ* and *Caprimulginæ*. The latter only is represented in North America, and by two genera, *Antrostomus* Gould, the whippoorwills, and *Chordeiles* Swains., the nighthawks; the former of which contains three species, the latter two.

The common whippoorwill (*A. vociferus* Bon.) is an inhabitant of eastern North America from Canada to Florida, where it is replaced by the chuck-will's-widow (*A. Carolinensis* Gould). Its range to the westward appears to be restricted to Leavenworth, Kansas,* where it is again represented by a still smaller species, the *A. Nuttalli* Cass., or "poor-will."

It is a summer sojourner in the District of Columbia, where it usually arrives from the south the last of April or the first of May. Although I have observed it as early as the thirteenth of April its arrival at that early period is of rare occurrence. The males generally precede the females a few days, and soon after the latter

* Bull. Mus. Comp. Zoöl. July, 1872.

make their appearance the wonted and necessary place for incubation is prepared. It cannot, however, be called a nest; as it is merely a shallow hole scraped in the ground, in close proximity to its accustomed companion, a rock, stump, or fallen tree. The eggs are from one to three in number, of a delicate creamy-white color, with blotches of different shades of lilac and pale brown: they are laid in the early part of May. The young are out by the first of June, if not earlier, and are very curious looking little creatures, covered with a fine down of a yellowish color. As soon as they are able to leave the nest, the mother guides them in their search for insects until they are able to use their wings. When surprised in these excursions, it is amusing to witness with what solicitude she hastens to lead them to a safe retreat. But if the intruder (especially if a human being) persists in following, and approaches too closely, she turns off in another direction, feigns lameness and incapability of flight, flutters along for a few rods ahead, and exerts herself to the utmost to allure the interloper from her offspring. After having decoyed the stranger, as she thinks, a sufficient distance, she suddenly regains her power of flight, and darts off to the protection of her helpless progeny. This species roosts almost exclusively on the ground, although it has occasionally been found upon a tree. When disturbed in the daytime it rises as silently as a shadow, and flies off in a confused zigzag manner, but immediately settles within a few rods. But when the shades of evening advance it comes boldly forth from its roosting places in the most invious and secluded parts of the forests, to search for the night-flying *Lepidoptera*, of which it destroys countless numbers. It is then that we hear its lively whistle in company with the loud, hoarse, guttural hŏŏ-hŏŏ-hŏŏ-hŏŏ-ē, of the great-horned owl (*Bubo Virginianus*); the quivering-wailing cry of the screech owl (*Scops asio*); the croaking of frogs, and the song of the cricket and the katy-did: which form quite a contrast to the beautiful songs of the thrushes which enliven our forests and groves during the day.

The chuck-will's-widow (*A. Carolinensis* Gould) is the largest North American species. In its habits and general appearance it resembles the common whippoorwill, with which it is generally confounded by inexperienced observers. Its range in the United States has usually been supposed to be limited to the south Atlantic and gulf states, being seldom if ever seen north of the Caro-

linas on the coast. But Mr. Ridgway is confident that he has heard it in southern Illinois;* which, if his observation proves correct, will be but another instance exemplifying the well-known fact of birds having a more extensive latitudinal distribution in the interior than upon the coast; which is doubtless subject to, and explicable by, climatic influence. Its notes, from which it takes its name, resemble less then has generally been supposed the syllables "chuck-will's-widow." They are pronounced in a rapid manner with a slight elevation of the voice upon the last syllable. Butterflies, moths and a variety of other insects, form its food, as they do also that of the other members of this group.

The next is Nuttall's whippoorwill (*A. Nuttalli* Cass.), or more properly "poor-will," as it is said to omit the first syllable. It inhabits the country west of the Mississippi river, and is domiciled in nearly every part of that vast extent of prairies. This is the smallest species, measuring only eight inches in length. Its habits differ essentially from its eastern congeners, as it is necessarily an inhabitant of open portions, and is unconversant, if I may so use the expression, with the woods which they so delight in frequenting. The eggs are immaculate livid white and destitute of spots or blotches, and, with *A. macromystax* of S. Mexico, differ in this respect, from all the other species.

We now come to the nighthawks (*Chordeiles*). The common nighthawk or "bull-bat"(*C. popetue* Baird) of the eastern states is abundant from British America to the West Indies, and west to Kansas, where it becomes lighter, and constitutes the variety *Henryi* Cass. This bird is an abundant spring and autumn visitant to the District of Columbia, arriving about May first, and departing the last of September. In its breeding habits it differs from the whippoorwill in constructing its nest, which is a mere hole scratched in the ground, in open places, as fields and bare hillsides; and never in thick woods. It sometimes deposits its eggs on a dead leaf, or even on a bare rock. During the pairing season the actions of the male are strange and interesting. At dusk he frequently mounts high into the air, and then, partially closing his wings, descends with great rapidity to near the earth; the air in passing through the wing feathers in this rapid descent produces a loud booming sound which may be heard at a considerable distance, and has been likened to the noise occasioned

* MS. Notes on Birds of S. Illinois.

by blowing into the bung-hole of an empty barrel. This noise must be regarded as a means of bringing the sexes together, as it is heard only in the spring. In the intervals between his ascensions, the male darts around in every direction, uttering sharp squeaks and throwing himself into all sorts of attitudes and postures, calculated, no doubt, to please any passing female. It is both diurnal and nocturnal in its habits, but more properly the latter. Nevertheless, I have frequently seen numbers pursuing and capturing their prey in broad daylight, when the sun was shining brightly. At such times, however, their flight is very high, so high indeed that they resemble the swallows with which they associate, and if it were not for the slow and regular flapping of their long wings, and an occasional harsh note (a note of exultation perhaps as they snap up some unfortunate beetle or moth) they might readily be mistaken for them. But it is in the dusk of the evening that they may be seen in the greatest numbers; when, in certain localities and at certain seasons of the year (especially in the fall), thousands may be seen darting around in their rapid and necessarily irregular flight. As darkness approaches, they descend to the earth and skim along the surface, snatching up any ill-fated bug that may have failed to find shelter.

I recollect a small valley in the northern part of Pennsylvania, which appears to be a favorite resort of this bird, more especially in the fall. It is about five miles in length, a mile in width, is inclosed by two ranges of high mountains, and is one of the most picturesque places in the state. A small stream wends its way along the base of one of the ranges and empties itself into the Susquehanna hard by. An hour or two before dusk a few night-hawks will be seen approaching from the direction of the river. These have no sooner passed than more make their appearance; and thus they come in an ever increasing stream, twisting and turning in pursuit of their insect prey, but always keeping in a general direction up the valley. In about fifteen minutes the foremost will have reached the head of the valley, and having turned, as is their invariable custom, will be seen drawing near in their return to the river. In this way they may be seen coming and going with continually increasing numbers, until the sky is dark with their fleeting forms, and night has thrown a veil over their actions. I have watched them for hours in this locality. When they first appear they are high in the air, but as dusk ap-

proaches their flight is lower; which is occasioned by the insects that they are pursuing seeking shelter for the night. Unlike the whippoorwill, this bird roosts almost entirely upon trees; in fact it is seldom found on the ground except during the breeding season. In roosting it always rests in a parallel position with its perch. This is undoubtedly owing to its comparatively small and weak legs, which are not capable of sustaining it any length of time in a transverse posture.

The western nighthawk (var. *Henryi* Cass.) was formerly considered to be a distinct species, but is now regarded as only a geographical variety of the preceding; the principal difference being a paler coloration caused by a predominance of the lighter markings. It inhabits the same region as Nuttall's whippoorwill, or the whole of the western country.

The Texas nighthawk is much smaller than either of the preceding, and is very distinct, its nearest relative being a South American species (*C. acutipennis*). It is a more southern bird than the others, and is found most abundantly in the state from which it derives its name.

DIAGNOSES OF GENERA AND SPECIES OF NORTH AMERICAN CAPRIMULGINÆ.

A. Wings, comparatively speaking, short and rounded, with rufous spots; second quill longest; the primaries emarginated on their outer webs. Tail broad and graduated, the terminal third, half or two-thirds of three outer feathers rusty white. Plumage soft and lax. The gape armed with very large and stiff bristles. Entirely nocturnal in habits. ANTROSTOMUS Gould.

1. Length 12·00; extent 25·00; wing 8·50; tail 6·50. Prevailing color above and below pale rufous; top of head reddish brown, streaked longitudinally with black. Terminal two thirds of three lateral tail feathers rufous white, with a slight mottling on all the outer webs for nearly their whole length. Tail but slightly graduated, the exterior feathers a quarter of an inch only shorter than the middle ones. Bristles of bill with lateral filaments. Female without white patch on tail. Habitat, south Atlantic and gulf states. Cen. Amer., S. Ill.? *A. Carolinensis* Gould.
2. Length 10·00; extent 19·25; wing 6·25; tail 5·00. Top of head, rump, upper tail coverts and inner tertials, ashy-gray, barred longitudinally with black; the streaks on the head becoming confluent in the centre, forming a large medial black band. Middle of back brownish black. Throat and fore breast the same. A white collar on the under side of the neck, the ends extending up on each side and nearly meeting a rufescent band curling around the nape. Rest of under parts light brownish white, barred transversely with dark brown. Wings brown, the quills spotted with rufous. Tail dark brown, with about eight interrupted light bars; the terminal half of three outer feathers rusty white. Graduation ·80. Bristles of mouth without lateral filaments. Female with no white on tail. Habitat, eastern U. S. to Kansas. *A. vociferus* Bon.
3. Length 8·00; wing 5·50; tail 3·65. Predominant color brownish-gray; top of head hoary gray, with transverse instead of longitudinal black stripes. A collar, or rather patch, of white on the neck, posterior to which the fore part of breast is black mixed with yellowish. Wings cinnamon color

spotted with brownish black. Tail dark on the terminal half, the tip for only about an inch, white. Graduation of tail ·50. No filaments to the bristles of the mouth. Habitat, high central plains to the Pacific coast. *A. Nuttalli* Cass.

B. Wings very long and pointed, with a white bar across the outer primaries about midway between the carpal joint and the tip of the wings: the primaries not emarginated, the first and second equal and longest. Tail narrow and forked, with a small white bar, in the males, across all the feathers except the two central ones. Plumage rather compact. Bristles of the mouth scarcely appreciable. Partially diurnal in habits. CHORDEILES Swains.

1. Length 9·50; extent 21·50; wing 8·20; tail 4·60. Upper parts almost uniform greenish black with a mottling of yellow and ash. Under parts soiled white, transversely barred with brown. A pure white V-shaped mark on the throat commencing about a quarter of an inch behind the base of the lower mandible, the acute angle anterior, the branches curving back on each side to a point beneath and posterior to the eye. The angle of this mark is filled up with rusty tipped feathers. Wings nearly black, the upper coverts speckled with ashy. The five outer primaries with a pure white bar across them about half-way between the first joint and the end of the wing. Tail brown, with about eight transverse irregular bars of mottling, which are nearly white below, and light brownish gray above. The terminal blotch on all but the two middle feathers is white on both surfaces, larger and more quadrate, and scarcely reaches to the outer edge of the feathers. The female lacks the white throat marks, the white spots on the tail, and the wing patch is much less conspicuous. Habitat, eastern North America to Kansas. *C. popetue*, var. *popetue* Baird.
2. Similar to the preceding but much lighter. Habitat, whole of western country. *C. popetue*, var. *Henryi* Cass.
3. Length 8·40; extent 19·00; wing 7·00; tail 4·60. Above brownish black mixed with gray and rusty mottlings; the top of the head rather more uniformly brown. Nape furnished with a finely mottled collar of grayish and black. Scapulars and wing coverts finely variegated, the pattern somewhat irregular, and scarcely capable of definition A proportionally larger V-shaped white mark on the throat than in *C. popetue*. Rest of under parts dull white, transversely barred with brown, with a tinge of rufous on the abdomen and under tail coverts. Wings with round rufous spots, similar to those in the whippoorwills; the four outer primaries only with a white blotch across them, which is much nearer their tips than the carpal joint. Tail dark brown, with about eight lighter bars, the last white, extending across both vanes. The female lacks the the caudal patch. Habitat, southern portion of western North America. *C. Texensis* Lawr.

FARTHER OBSERVATIONS ON THE EMBRYOLOGY OF LIMULUS, WITH NOTES ON ITS AFFINITIES.*

BY A. S. PACKARD, JR., M.D.

In a recent paper on the "Embryology of Limulus," published in the "Memoirs of the Boston Society of Natural History," I stated

* Read at the Portland Meeting of the Amer. Assoc. Adv. Sci.

that the blastodermic skin, just before being moulted, consisted of nucleated cells, and also traced its homology with the so-called amnion of insects. I have this summer, by making transverse sections of the egg, been able to study in a still more satisfactory manner these blastodermic cells and to observe their nuclei before they become effaced during and after the blastodermic moult.

On June 17th (the egg having been laid May 27th) the peripheral blastodermic cells began to harden, and the outer layer, that destined to form the "amnion," to peel off from the primitive band beneath. The moult is accomplished by the flattened cells of the blastodermic skin hardening and peeling off from those beneath.

During this process the cells in this outer layer lose their nuclei, and, as it were, dry up, contracting and hardening during the process. This blastodermic moult is comparable with that of Apus, as I have already observed, the cells of the blastodermic skin in that animal being nucleated.

This blastodermic skin in its mode of development may also safely be compared with the "amnion" of the scorpion as described and figured by Metznikoff, and we now feel justified in unhesitatingly homologizing it with the "amnion" of insects, in which at first the blastodermic cells are nucleated, and appear like those of Limulus. Moreover the layer of germinal matter, from which the blastodermic skin moults off, may be compared with the primitive band of insects. On June 19th, in other eggs, the cells of the blastodermic skin were observed to be empty, and the nuclei had lost their fine granules, and were beginning to disappear. The walls of the cells had become ragged through contraction, and in vertical section short peripheral vertical radiating lines could be perceived.

At this time an interesting phenomenon was observed. In certain portions of the blastodermic skin, or amnion, the cells had become effaced, and transitions from the rudiments of cells to those fully formed could be seen. From this we should suppose that the retention of these cells in the amnion of Limulus is due to the singular function this skin is destined to perform, *i.e.*, to act as a vicarious chorion, the chorion itself splitting apart and falling off in consequence of the increase in size of the embryo. In insects these cells disappear, and after the skin is moulted it appears structureless.

From studies afterwards carried on in the laboratory of the

Anderson School of Natural History, on the anatomy of the adult Limulus, I have been able to fully confirm the important discovery of Prof. Owen (Lectures,) 1852 and more recently of M. Alphonse Milne-Edwards* relative to the sheathing of the nervous cord and its branches by a system of arteries, and I would here bear testimony to the accuracy of Edwards' drawings and descriptions. Moreover I have been able by a study of living Limuli, beautifully injected by Mr. Bicknell by the kind permission of Prof. Agassiz, the director of the Anderson School, to extend still farther the anatomical researches of Milne-Edwards. With Mr. Bicknell's aid I have ascertained the existence of still smaller arterial twigs, on the peripheral subcutaneous portion of the body, than indicated by Milne-Edwards, and have made out the existence of an extensive series of closed vessels in the respiratory abdominal feet. For this I was prepared by a study of the respiratory lamellæ, which, in the arrangement of their chitinous septa, may be closely homologized with the gills of Amphipod Crustacea, as observed in living specimens without injection.

With the new information afforded us by A. Milne-Edwards, regarding the relations of the nervous cord with the ventral system of arteries, and the remarkably perfect circulatory system, so much more highly developed than that of any other Arthropod, I should no longer feel warranted in associating Limulus and the Merostomata generally with the Branchiopoda, but regard them, with the Trilobites, as forming perhaps a distinct subclass of Crustacea.

Certainly if we consider the relations of the anatomical systems to the walls of the body, the disposition of the segments forming those body walls, and the nature of the appendages, Limulus is built on the crustacean type. Because its nervous cord resembles that of the scorpion, and its circulatory system is more perfect than that of any Arthropod we know, this is no reason for assuming that it is not a Crustacean. On the same ground Ceratodus is not a fish because it has the lungs of a reptile, nor is Ornithorhynchus a Saurian because it has the shoulder girdle of a Saurian.† I have, moreover, shown that some important features in the embryology of Limulus are like those of the scorpion and the hexapodous insects, the "amnion" of Limulus apparently being homologous with that of the insects.

* Recherches sur l'Anatomie des Limules. Annales des Sc. Nat., 1873.

† I have been reminded by Professor Wyman of this peculiarity in Ornithorhynchus as stated by Meckel.

In fact Limulus seems to me to be a synthetic or comprehensive type, bearing the same relations to the Crustacea that Ceratodus does among the fishes, or Archæopteryx among the birds; and because Limulus has strong analogies to the Arachnida, we should not overlook its true affinities with the Branchiopodous Crustacea.

Limulus may, then, be regarded as a Crustacean with the carapace of Apus, bearing simple and compound eyes as in that Phyllopod, with the antennæ foot-like as in many Entomostraca, and the abdominal appendages truly crustaceous in their structure, while the circulatory system is not fundamentally unlike that of other Crustacea, but only more perfect, and the digestive system is throughout comparable with that of the normal Crustacea.

ON A REMARKABLE WASP'S NEST FOUND IN A STUMP, IN MARYLAND.*

BY P. R. UHLER.

THE insects of the genus Polistes have not hitherto been reported to make nests of clay. All the North American species have been considered paper-nest-builders. Many species are known from the United States, Canada and the West Indies, and these are generally of a brown or yellow color, having spots or bands either lighter or darker.

In the present instance we have a dark brown species with narrow yellow bands across the abdomen, and with yellow feet, which builds a nest of clay in the form of a cylinder. In the stump of a decayed Liriodendron, found by O. N. Bryan, Esq., in Charles county, Maryland, a number of these insects had aggregated their cylinders. The stump was about two feet in diameter and the central cavity (which had been formed by the borings of large beetles) was five inches wide. In this, attached to the sides, sometimes lying flat in the grooves left by the beetles, or standing off at a considerable angle, and attached by their bases, were thirty-three of these peculiar structures. They were of a yellow clay, generally about half an inch in diameter, and varying in length

* Read at the Portland Meeting of the Amer. Assoc. Adv. Sci.

from two to five inches. Sixteen of these were attached in one group projecting from the side of the cavity, and towards their outer ends were bent into a blunt curve; resembling a colony of the tubes of Serpula.

The nest, or, more properly, receptacle for the egg and young, is constructed in this manner. The adult Polistes flies to an adjacent place where there is suitable wet clay, works this substance into an oval pellet and flies to the place where the building is to be made. The pellet is then laid obliquely and pressed down by the fore feet and head of the insect so as to cause it to adhere firmly to the surface on which it is building. This operation is repeated until it has formed a cylinder about one inch in length.

As it proceeds, it smooths the inside of the cylinder by working with its jaws and pushing the front of its flat head against the plastic clay. The first section being thus finished to its satisfaction it flies off to secure small spiders. It seizes a spider with its fore feet, stings it in just such a way as to paralyze, without destroying its life, and then deposits it in the bottom of the cylinder.

An egg is then laid beside the spider, and the wasp flies off to secure other spiders. This is continued until the cavity, which generally holds from twelve to fifteen of the smaller kinds, is full.

The wasp then proceeds to cover the open end with a cap of the same material as before, after which it adds other sections to the number of three or four, filling each with spiders, and depositing one egg in each. The young larva feeds on these paralyzed spiders, and, as it seems, requires from twelve to fifteen of them to nourish it until it is ready to become a pupa.

Unlike the species of Pelopæus, which also make clay nests, it does not nurse its young, but they are securely sealed up in the sections to feed themselves. When ready to come forth, the wasp gnaws a round hole in the wall of its cell, and flies forth as a perfect insect.

A similar, if not identical, species was very troublesome in Baltimore during the early part of last summer.

On the front walls of the Peabody Institute these wasps assembled in considerable numbers; and constructed their cells in the grooves of the joints of the marble. Their clay cylinders were so numerous as to greatly disfigure the marble and render it necessary to have the front of the Institute cleaned.

THE FERTILIZATION OF FLOWERS BY INSECTS AND THEIR MUTUAL ADAPTATION FOR THAT FUNCTION.*

THE old idea, once a favorite topic with poets and divines, that the beauty of the external world was intended exclusively to promote the enjoyment of mankind, has suffered many severe shocks from the rude onslaughts of modern science. The discovery that the earth was a habitable and inhabited world, countless ages before man appeared upon the scene, might be explained on the hypothesis that it was thus becoming prepared for the advent of the masterpiece of creation; the egotism of the human species might even survive the discouraging fact that gems of purest ray serene were born in the unfathomed caves of Silurian or Devonian oceans, and that flowers of the most perfect beauty were born to blush unseen in the midst of oölite or cretaceous deserts. The unpitying theory of the survival of the fittest, however, points relentlessly to the conclusion that man after all is not the *raison d'être* of anything he sees around him except himself; that "jedes für sich" is the rule of nature; that every organic being is contrived so as to have the best chance of supplying its own wants, and not for the sake of administering to the wants of others; in fact that the philosophy of science must, for the future, be an application to the realms of nature of the principle of self-love, such as even a Hobbes might accept.

The volume before us, though full of minute details of empirical observation, is an important contribution to this philosophy of science. The main fact which forms the groundwork of Prof. Müller's observations is not new. Towards the close of the last century one of the keen observers of nature with which that period abounded, C. C. Sprengel, in his *Das entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen*, pointed out that a number of the different forms which the flowers of plants assume are obviously contrived for the purpose of attracting insects and of enabling them to carry away the pollen which is required to

* *Die Befruchtung der Blumen durch Insekten und die gegenseitigen Anpassungen Beider. Ein Beitrag zur Erkenntniss des ursächlichen Zusammenhanges in der organischen Natur.*—Von Dr. Hermann Müller. Leipzig: Engelmann.

fertilize other flowers of the same species. This line of research, which had been almost lost sight of since Sprengel's time, has been renewed in our own day by Darwin in this country, the writer of this volume and Hildebrand in Germany, Axell in Sweden, and Delpino in Italy; the first-named naturalist reducing the sum of his observations to the well-known aphorism that "nature abhors perpetual self-fertilization." The whole of that complicated structure which we call in ordinary language the "flower" of a plant consists, in fact, of the reproductive organs enclosed in a number of envelopes which have for their purpose not only the protection of the essential organs within them, but the attraction of those insects or other animals which are necessary for the fertilization of the ovules.

The contrivances for effecting this purpose, though infinite in number and variety, may be classed under two principal heads, color and scent. A large number of insects obtain their food chiefly or entirely from the juices of flowers; and the necessity for cross-fertilization renders the visits of these insects as indispensable to the life of the flower as to that of the insect. To enable them to find this food the juices are very commonly scented; a field of clover or beans will attract all the bees in the neighborhood from a great distance; and, if carefully watched, the bees will be found not only to carry off with them the honey, but to transfer also a portion of the pollen from flower to flower. Where the juice of the flower does not happen to be scented, the bright color of the corolla commonly serves the purpose of attracting insects from a distance. Different insects and other small animals have apparently very different ideas of beauty as regards the form and color of the flower. Hummingbirds are said by Delpino to have a penchant for scarlet and for flowers with long wide tubes; hence in countries where there are no hummingbirds, as our own, scarlet flowers or those with long wide tubes are very rare among native plants.* The largest-flowered of European plants, the peony and several species of convolvulus, are visited chiefly by large beetles allied to the cockchafer; and as we proceed farther north to climates too cold for this description of insect, the corresponding flowers also disappear, not being able to mature their seeds without assistance. When fertilization is effected by very

* Among our common wild flowers it would be difficult to name any of a true scarlet hue except the poppy and the little pimpernel.

small insects, something more than a large conspicuous corolla is required to show the visitors the way to the nectary or receptacle for the honey; hence arises the variegation of flowers, the bands or patterns of color being almost invariably so arranged as to direct the insect in the way it should go in search of food. As nature seldom provides two contrivances, concurrently, for the same purpose, we find that variegated (wild) flowers are seldom scented; while the most odoriferous flowers are almost always uniform in color; the evening primrose, which opens its scented flowers only in the dusk, requires no variegation to direct the night-flying moths to the scented nectar.

Illustrations of all these laws have been observed by the naturalists we have mentioned, and have been collected with great industry in this volume by Dr. Müller, himself no idle worker in the same field. According to the theory of natural selection, those descendants from a common ancestor which vary from the others in any direction that tends to increase their attractiveness to insects, or to secure a more certain transference of the fertilizing pollen from one flower to another, will have the best chance of survival and of perpetuating and increasing this peculiarity in their progeny. Dr. Müller has himself examined, or records the observations of others on, nearly four hundred species of plants, and describes the structure of the reproductive organs and of their envelopes, with especial reference to their adaptation for self-fertilization or for cross-fertilization, giving in each case a list of all the insects which have been observed to visit the flower, and illustrating his description, where necessary, by admirable woodcuts. This portion of the subject is more or less familiar to most botanists; what Dr. Müller has made peculiarly his own study is the tracing out of the same principle, applied to the visiting insects, as previous observers have noted with respect to the visited flower. By the same principle of natural selection those insects which display to the greatest perfection contrivances for extracting the honey of flowers or for carrying away the pollen — the latter serving in some cases for their own food, in others for storing up in their nests as food for the larvæ or young — will stand the best chance of perpetuating offspring provided with the same peculiarities; and we find here abundant descriptions and drawings of the various forms which these contrivances assume in different classes of insects.

In his concluding chapter Dr. Müller discusses the origin of

these phenomena, and declares himself a firm adherent of Darwin's theory, finding the explanation of every special contrivance on the one side or the other in the principle to which we have already referred. He therefore vigorously combats the teleological views of Sprengel and Delpino, the latter of whom especially, while accepting the theory of evolution or descent with modification, yet disputes the soundness, or at least the adequacy, of the other theory usually associated with it, that of natural selection. He recurs, in fact, to the pre-Darwinian doctrine of design, to account for the phenomena which furnish the subject of this work, or, as Müller represents him: "Nature is with him a being endowed with human thought, which has invented definite forms of flowers leading necessarily to cross-fertilization; and this is then completely carried out by the employment of different parts of plants for the same purpose. This creator of flowers, far exceeding in talent the cleverest man, has predestined certain forms of flowers for certain insects, and certain insects for certain forms of flowers, and has contrived each one to fit the other." The reasons which may be adduced against this theory would be simply a repetition of the main argument of Darwin's *Origin of Species* and *Variation of Animals and Plants under domestication.* The believer in the doctrine of natural selection finds it more consonant with the facts which he sees around him to assume that Nature—if it is possible to personify the idea—works, not by preconceived notions and prearranged harmonies, in which case we should expect to find everything perfect, without discord, waste, or incompleteness; but rather, as a human workman would act, tentatively; making small improvements here and slight adaptations there; every form of life, in fact, constantly approaching a more and more perfect adaptation to the circumstances in which it is placed, a perfection which, however, is never absolutely attained.

There are few regions of scientific inquiry more easily open to any observer resident in the country and possessed of ordinary powers of observation, than those connected with the fertilization of flowers, and none which would more amply repay careful research by leading to further insight into the still hidden laws which govern the origin of species. To all workers in this field Dr. Müller's elaborate and in every respect admirable work will be an indispensable companion.—A. W. BENNETT, *in the Academy.*

REVIEWS AND BOOK NOTICES.

THE HUMAN BRAIN.*—As the title indicates, the main purpose of this work is anatomical rather than physiological; for the author well says that "not the least of the obstacles in the way of solving the problem" of the relation between mental faculties and cerebral convolutions is the present "difficulty of recognizing the constant unity of form in the multiplicity of individual variations:" and he wishes his outline figures "to be regarded not so much as pictures as maps by which one may find his way more easily in this region." In other words, the four diagrams of the human brain as seen from the left side, from above, from below and from the mesial surface, must be accepted by the reader, not as accurate representations of any single brain, but as the generalized results of the author's comparison of several brains, the individual variations of which are capable of being referred to these diagrams as types.

The value of such a generalization might be estimated if the author had given us the number of individuals upon which it is based; his statement that *fœtal brains* were studied, is so far satisfactory as evidence of a correct method; but in the absence of any figures of these latter, we can test the correctness of his generalization only by comparing his diagrams with actual specimens. And without going into technical details, which would be here out of place, we must state that such a comparison with ten cerebral hemispheres, representing four different periods of fœtal life, has enabled us to confirm Ecker's views with respect to the nature of only two main outer fissures, those of Sylvius and of Rolando (*centralis*), respecting which there has never been any disagreement. We are the more willing to admit this failure to agree, because our author himself dissents from previous writers. But while insisting upon the differences from his type pattern, which are manifested by our specimens, we are firmly convinced of the futility of establishing a pattern based upon them or upon a much larger number of specimens. Indeed we hail the discrep-

* The Cerebral Convolutions of Man, represented according to original observations, especially upon their development in the fœtus. Intended for the use of physicians. By Alexander Ecker of Freiburg (1869). Translated by Robert T. Edes, M. D. 1873. 8vo. pp. 87. $1.25.

ancy as another proof of three views elsewhere urged by us; 1. That a *very large* number of specimens especially of fœtal brains, must be carefully studied. 2. That the results must be checked by an equally careful comparison between the *two halves of the same brain.* 3. That the existing disagreement is likely to persist for a long time unless we discard the human brain for the simpler brains of the lower monkeys, the lemurs and *carnivora*, using large numbers of brains of *nearly allied* species. But the foregoing considerations do not hinder our acknowledgment that the present work is a real boon to anatomical science; since it for the first time renders it possible, for the reader of English only, to ascertain what has been done in cerebral topography; the figures are clear, the nomenclature uniform, and a full synonymy is prefixed to the description of each fissure and fold.

The fissures, are, correctly as we think, stated to be the "more important," but upon what ground is not indicated; and there is given a brief account of the formation of the Sylvian fissure, as differing from all others: a point which has been in part confirmed by our own observations upon the brains of young animals.

We are now inclined to return to the ancient belief that each cerebral hemisphere acts as a unit and with more or less vigor according to the number and depth of the fissures; but Ecker vigorously repudiates this idea, holding that it "consists of a multitude of organs each of which subserves definite intellectual processes." But this opinion, while according with the original idea of phrenology, by no means indicates our author's estimate of the present "professors" of that "science" to whom, together with the rest of this admirable little work, we cordially recommend the following passage (p. 9). "The travelling phrenologists, who wander around with plaster heads of Schiller, Napoleon and some celebrated rascals, and cipher out a character from a number of bumps on the skull, are well known. Few of them have ever seen a brain."—BURT G. WILDER.

INFUSORIAL LIFE.*—Under this title Mr. W. H. Dallinger and Dr. J. Drysdale publish, jointly, in the August No. of the "Monthly Microscopical Journal," an article of extreme interest as a natural history contribution, and of revolutionary importance

* Researches on the Life History of a Cercomonad: a Lesson in Biogenesis.

in respect to the prevalent methods of investigating questions of "spontaneous generation." Dissatisfied, as most thinkers are, with the vague and uncertain methods and conclusions of heated infusions and sealed flasks, the authors turned for an answer to the life history of the individual monads, and fortunately succeeded in obtaining the history of a species which might easily have been described as a group of species or quoted as an organism of spontaneous origin.

The necessity for a change in the methods of study in biogenesis is well stated in their words, as follows:—"The question as to whether vital forms of the lowliest and minutest kind may have their origin in a new, and as yet unexplained, arrangement of non-vital material, is one that can never find a legitimate and final reply in the class of experiments employed to test it within the last thirty years. A careful student of the literature of the subject will see that the *results* obtained by the same and different experimenters, with similar infusions and solutions, are so uncertain, and often contradictory, as to leave the whole question open to bias; and an almost equal array of so-called 'experimental facts' from nearly equally trustworthy observers, may be quoted on either side. This may be all pleasant enough in a 'wordy war,' but it does not even approximate to a decision of the issue, and points to insufficiency in the experiments employed. The appearance or non-appearance of organic forms in certain infusions placed in sealed flasks or tubes, or otherwise conditioned, is held to be decisive of their production *de novo* or otherwise; but in point of fact we know *nothing*—absolutely nothing—of the life history of the greater number of the forms produced. To attempt to decide, therefore, from the experiments as yet published, that their production in gross masses in inorganic infusions proves that inorganic elements produced them, may be to beg the whole question. Inferring from what we *know* of nature's modes of reproduction, we have a right to expect, not a *de novo* production, but a production from genetic elements. But when we remember the relation in size, throughout nature, between the ova and spermatozoa and the organism producing them, the fact that no such elements are visible (if they exist) in Bacteria or monads is probably a mere necessity of our present instrumental power. At least this is inevitable, that before we can be scientifically certain that these lowly forms do or do not originate in non-vital

elements, we ought to know their life-history; and if this be desirable in the question of abiogenesis, it must be absolutely essential before we can even approach that of heterogenesis. We must patiently follow them without a break in observation, through all their changes, and then, by repeating these observations, decide on the stability or otherwise of the form. For some years our attention has been individually directed to this subject; and three years since the advisability of combined work commended itself to us. For work of this kind to be effective, we believe there must be more than one observer, in order that the observations may be unbroken as far as possible, and also to secure a mutual as well as a double confirmation."

With Ross' medium powers, and Powell and Lealand's high ones, the authors commenced the study of an undescribed monad which sometimes occurs abundantly in water in which a cod's head has been macerated. The drop of infusion was so arranged that it could be preserved in the focus of the highest powers, and the organisms inhabiting it maintained alive and healthy, and under continuous observation for an indefinite length of time.

The cercomonad subjected to study was a small oval body with two actively moving flagella at one end. This was the familiar, mature form, and the one which, alone, according to the usage of the students of Infusoria, would be considered characteristic of the species. Other forms however were observed, differing in size and shape and with one flagellum at each end, or amœboid with or without flagella, or cyst-like and smooth and globular; forms each of which might easily be regarded as a distinct species or possibly as a capricious variety, but which were tracked through a series of transitions, the recurrence of which was repeatedly observed and was found to be unvarying and to be a portion of the life history of the same individual. The mature form with oval body and two flagella at one end, after moving about with great activity for a period of time which in the observed cases was about forty minutes, became squarer or more elongated, and somewhat dumb-bell shaped by a sudden constriction of the sarcode. At this stage the body is furnished with one flagellum at each end, which lashes with great force. The constricted portion becomes narrowed more and more by stretching until so attenuated as to equal only the flagella in thickness, when it parts in the middle, leaving two separate bodies each furnished with a flagellum at each end.

This multiplication by fission, in an average of forty cases, was completed in four minutes and forty seconds, and continued to be repeated without variation during from two to eight days.

After this period the organism gradually assumes an amœboid form by pouring out a delicate sarcode, and moves only by pseudopodia although the flagella are still present and somewhat active. In the course of seven hours, there were several of these amœboid forms in the field, each enclosing or enveloping a flagellated body. Finally two of these approached each other until they touched, and rapid blending of the sarcode took place, the flagella disappeared, the bodies came in contact with each other and rapidly coalesced, and the common body thus formed increased in size until it was no longer enveloped in the delicate sarcode, but became a mere, smooth, globular cyst with a distinct integument which afterwards became thin, burst, and discharged a viscid mass of oily looking matter. Under the power employed, Powell and Lealand $\frac{1}{50}$ and A ocular ($\times$ 2500), this presented, when somewhat dispersed, a minutely granulated appearance. By adding an eight inch drawtube and B ocular, it became certain that this consisted of a densely packed mass of inconceivably small granules. The observers believe that they should have wholly failed to see these sporules but for their enormous aggregation and motion in a mass, and that "*with the $\frac{1}{25}$ the most accurate observer could not have discovered their presence if he had not previously seen them with the $\frac{1}{50}$.*"

The development of these granules was now watched with the greatest care. In six hours they had increased to a decidedly perceptible degree, though still far smaller than the minute and familiar *Bacterium termo* of Cohn; an hour or two later they began to reassume an oval shape; in nine hours from the first they had become rather larger than *B. termo* and had become flagellate and begun to move freely, the bodies became vacuolate, and in something less than twelve hours the normal parent form was assumed. This history was traced carefully and repeatedly, and with unvarying results.

The effects of heat and dessication were also tried; and it was found that although drying slowly upon a glass slide and exposure to a dry heat of 121° C. entirely destroyed all the adult forms, yet, after moistening again with distilled water and watching the field for some hours, growing points were in some instances dis-

covered exactly resembling an early stage of the developing sporules, which points matured into the flagellate state. Farther experiments demonstrated that a heat, without dryness, of 66° C. destroys all the adult forms, while young monads appear and develop in an infusion which has been heated to 127° C., suggesting that the *sporules are uninjured by a temperature which is destructive to the adult.*

After this history, whose importance, if verified by subsequent observation, can scarcely be over-estimated, a history of a monad multiplying by subdivision, reproducing by conjugation (a true sexual reproduction of an extremely simple type), and actually seen to develop from sporules invisible under the powers usually employed in such investigations, and indestructible by heat which is fatal to the adult forms, it seems almost a waste of time to read of experiments with boiled infusions in sealed flasks, and we are rather inclined to wait patiently until Powell and Lealand or Tolles, or some one else, shall give us a lens capable of reading the life-history, whatever it may be, of Bacteria and Vibriones.— R. H. W.

BOTANY.

Perforation of Gerardia pedicularia by Bees.— I have always been much interested in the pretty genus Gerardia, largely represented in the vicinity of Providence, R. I. In the summer of 1871, while sitting amidst a dense growth of *G. pedicularia*, I noticed that all the humble-bees which visited the flowers alighted on the outside near the base of the corolla. I could not account for so singular an action, as the aperture to each bell was so wide. I found upon examination that the corolla in each case was pierced on the upper side near the junction with the calyx. I sent a note in regard to the matter to W. H. Leggett, Esq., of New York, and it appeared in the "Bulletin of the Torrey Club." The editor remarked that it was the first case, in his knowledge, of our native flowers being slit in this manner by visiting insects.

Not satisfied with what I then saw, I have watched the plants again this year with much attention, often sitting among them for an hour or more with the bees buzzing about my head. I should say that they were all humble bees, and I have seen but one of them approach the natural opening of the flowers. This was a much larger bee than any of the others. None of them had

their legs dusted with pollen. On one occasion I saw a small metallic green and iridescent bee among the flowers, but could not observe whether he entered them. The sweet odor of the flower is very heavy and oppressive.

Why should these insects perforate the corolla when the flower is apparently so easy of access in the usual way? Examination of the structure does not throw much light upon the matter. The corolla is bell-shaped and of funnel form. There are four stamens, two long and two short, the filaments clothed with hairs, which are probably bathed with nectar, as the perforation is made just above them. The anthers are two-celled, approaching by pairs, and each cell has a sharp cusp at the bottom, pointing inwards. The style is long, and the stigma is bent over the longer stamens. I find, upon inserting a pencil into the mouth of the flower, that, upon retracting it, it is brought in contact with the cusps above referred to, which causes the anther cells to expand and discharge the pollen copiously. An insect acting in the same way would have its back dusted, and when visiting another flower, would necessarily rub off a portion of the burden upon the stigma. I thought the sharp cusps might tickle or prick any intruder and thus compel him to retreat. Dr. Gray, however, does not consider these projections sharp enough to annoy the bee, and moreover considers it improbable that the flower would be provided with a contrivance so manifestly to its disadvantage. There are "guiding lines" of orange dots leading towards the nectariferous hairs.

I have seen bees approach the front for a moment and then retire as if baffled. Most of them, however, begin operations at the back at once. They alight with the tail towards the open end of the flower and at once insert the head into the little hole. I have never seen them make the aperture, although it is difficult to find a blossom without one. Even the buds are often penetrated; out of a large number of flowers plucked at random from different plants in different localities, I cannot find one flower without the slit. I have got others to observe for me with the same result. It is a constant pleasure to watch the curious action of these bees.—W. W. Bailey.

The Connecticut Valley Botanical Society held its first annual meeting at Amherst, Mass., Oct. 1. This new Society was organized in June last, mainly through the efforts of Mrs. Maria

L. Owen, of Springfield, Mass., and begins with a membership of about twenty ladies and gentlemen.—*President*, Prof. C. H. Hitchcock, Hanover, N. H.; *Vice President*, Rev. H. G. Jesup, Amherst, Mass.; *Secretary*, Mrs. M. L. Owen, Springfield, Mass.

Various papers of interest were presented at the meeting by the President and other members; an account of recent explorations near the head waters of the Connecticut river was given by one who had just returned from that region; a number of rare plants were exhibited; and work was planned for the coming year which promises valuable results. The society bespeaks the sympathy and coöperation of all the working botanists throughout the valley of the Connecticut river.—H. G. J.

Herbarium Paper.—The Naturalists' Agency purpose keeping herbarium paper for sale, in small quantities, and taking orders for it in larger quantities; both the white sheets for species, and genus covers, such as are used at the Gray Herbarium of Harvard University and by most of the principal botanists of the United States. Botanists and institutions now sending their orders for the white paper, for two reams or more, may be supplied at $5 per ream (unless the price of paper should meanwhile rise). Those who order after the first lot of paper is made will probably have to pay a higher price, as also will those who buy less than whole reams. The species paper sheets are $16\frac{3}{8} \times 11\frac{5}{8}$ inches. Orders may also be sent for genus-covers. These are of Manilla paper, very thick, $16\frac{1}{2} \times 24$ inches, *i.e.* a foot wide when folded. The price will depend somewhat upon the extent of the orders received, but will probably be about $7 a ream. Orders should be sent without delay to the Naturalists' Agency, Salem, Mass.

Lithospermum longiflorum only L. angustifolium.—While collecting specimens of *Lithospermum longiflorum* Spreng., in fruit, I noticed that the plants were still producing *small* flowers. A gradual reduction could be easily traced, from the conspicuous early inflorescence of the erect stem, to the small corolla scarcely exceeding the calyx, borne by spreading branches later in the season. This summer state of the plant is clearly *L. angustifolium* Michx.! within the limits of our familiar flora of the northern states, therefore, we have not only two species, founded upon different periods of growth of the same plant, but one of these has even been separated from *Lithospermum* and made the type of a

distinct genus, *Pentalophus* A. De C. It is a pity to lose the appropriate name of *longiflorum* but it must yield to the older one imposed by Michaux.—M. S. Bebb.

Rhexia Virginica L.—This species produces fusiform tubers and of course grows from them the following year. In the few books accessible to me here (Wethersfield, Conn.), "Gray's Manual," "Chapman's Flora S. U. S.," "Benth. and Hook. Gen. Pl.," no mention is made of this character of genus or species. Hence, I infer it is not generally known. Will botanists who can readily examine other species observe whether or not it is a generic character and let us know?—C. W.

Cleistogenous Flowers are produced late in the season, and almost exclusively by *Oxybaphus nyctagineus*, as observed by H. W. Patterson, of Oquawka, Illinois. In *Nyctaginia capitata*, of Texas, as cultivated in the botanic garden here several years ago, we noticed the opposite of this, *i.e.*, all the earlier flowers were cleistogenous.—A. G.

ZOOLOGY.

Notes on some of the Rarer Birds of New England.—The occurrence in New England of the birds here mentioned, and the nesting therein of many of them, will perhaps be of interest to some readers of the Naturalist:—

An ornithological friend, Mr. J. N. Clark, residing at Saybrook, Ct., writes me that the following species are found in numbers, and breed regularly, in that locality: *Icteria virens*, *Helminthophaga pina*, *Myiodioctes mitratus*, *Icterus spurius*, *Ammodromus maritimus*, *Myiarchus crinitus* and *Rallus crepitans*. He also observes in the nesting season *Helmitherus vermivorus*, but as yet has failed to find the nest. *Melanerpes erythrocephalus* also breeds, and a number remained with him all through last winter. Most of the above have usually been regarded only as rare and accidental visitors to the southern portions of New England, and the others as found but sparingly and locally in any section of it. The fact of the *blue-winged*, *yellow*, *worm-eating* and *hooded warblers* occurring constantly is, I think, of special interest. He sends me a specimen of *Seiurus Noveboracensis* and says, "I can testify that about the period of nesting they are most extraordinary singers." I think it possible, however, that the bird actually nesting with him

may be *Ludovicianus*. The shooting of the latter and finding its nest and eggs at Norwich, Ct., by Mr. E. Ingersoll, make the theory tenable.

One instance of the nesting of *Mimus polyglottus* has come to his knowledge. *Cathartes aura* and *Garzetta candidissima* he has seen rarely and has *heard* of *Cardinalis Virginianus*. All through the winter of 1872–73, *Sialia sialis*, *Dendrœca coronata* and *Melothrus pecoris* remained in flocks. The worm-eating warbler he finds in thickets on the edges of swamps,—a restless bird with a very strange, loud, rattling call; at other times he remarked a warbling song reminding him of that of the common goldfinch, only a little softer. *Sphyrapicus varius* is abundant in fall. He considers *Ammodromus maritimus* as being much more plentiful than *caudacutus*. His observations of *Oporornis agilis* are the same as those of Massachusetts collectors. It occurs only in the fall (September). My correspondent has kindly sent me specimens in the flesh, and nests and eggs of many of the above species in confirmation of what he has written me. No part of New England has been embraced within the Carolinian fauna, and properly so, but that its southern border has a tinge of it, is quite evident.

In this connection I will state that several *Melanerpes erythrocephalus* have been shot in eastern Massachusetts within about a year in both the adult and immature plumage. Two *Picoides arcticus*, both males, were shot in Middlesex county, late in the fall of 1871. A nest and eggs of *Icteria virens* were found near Lynn last June, the fourth nest of this bird that my informer has found in that locality. A fine specimen of *Herodias egretta* was killed in Westford; *Limosa Hudsonica* has been quite common along the coast this fall; a *Porzana Noveboracensis* was shot on Canton marshes, Oct. 15, 1872; a *Histrionicus torquatus* at Hampton, N. H., Nov., 1872; and two or three young *Sterna Forsterii* have been obtained on our coast within a year.—H. A. Purdie, *West Newton*, *Mass.*, *Sept.*, 1873.

On the Migration of Certain Animals as Influenced by Civilization.—During the autumn of 1850, I emigrated to the state of Wisconsin and settled upon what was known as the "Indian Lands," situated in the central part of the state, north of Fox River. The Indians were not removed, and very few white settlements had been made. The forests abounded in the usual

variety of wild animals including the deer, gray wolf and black bear.

As the entire fauna and flora seemed to be unchanged, a good opportunity was afforded for observing the influence of advancing civilization. Many interesting facts were observed in regard to both plants and animals, some of which may be of importance as illustrating the habits of certain species.

During the first winter, the raven (*Corvus corax*) was frequently seen, sometimes solitary, but more frequently in flocks of from eight to ten in number, flying along the watercourses or hovering over thickets into which a wounded deer had been chased. They were less frequently seen during the summer, probably going north to their breeding place, as no nests were ever found in that section. The country lying north and northwest was almost one unbroken wilderness to Lake Superior, while the southern boundary was formed by the Fox river at a distance varying from twenty to thirty miles.

During the following season a larger number of settlements were made, while the Indians were gradually removed. The ravens returned for two or three following seasons, though in diminished numbers. During this whole period, as far as I am able to learn, not a single specimen of the common crow (*Corvus Americana*) was seen or heard in the whole region. While he was a resident of the southern and eastern parts of the state, he seems to have carefully avoided the Indian lands. It was not till more than a year after the disappearance of the raven that the first crow, a single straggler, appeared, uttering his well known "caw," advancing northward evidently on a tour of exploration. He seems to have carried back a favorable report, for soon others appeared, and in a short time the species became very common.

Several interesting inquiries arise in relation to the habits of these animals. Do they ever exist together, or is there any antagonism between the species? Although the distance was not more than twenty miles to Fox river, the southern boundary of these lands, the raven was not known to advance farther south, nor the crow to visit the lands occupied by the former. Whether the raven is now found within the limits of the state I am unable to determine.

Dr. Coues in his "Key to North American Birds" gives the habitat of the raven "North America; but now rare in the United

States east of the Mississippi, and altogether wanting in most of the states. Very abundant in the West, there supplanting the crows." In the present case it would seem that the raven preoccupied the ground, *excluding* rather than supplanting the other species. The disappearance of the raven could not be owing to the wholesale and wanton slaughter so often practised by settlers upon the animals occupying the lands upon which they locate, for it was seldom that a specimen was shot. They were regarded as quite inoffensive, never being known to commit any depredations upon grain fields, and were allowed to range unmolested. It is quite probable their departure was owing to the increasing number of settlers, the opening up of fields, and other changes incident to new settlements.

Another example of the migration and succession of species was that of the four-lined squirrel (*Tamias quadrivittatus*). This sprightly little animal was very common, being seen everywhere through the forests and around settlements, while not a single specimen of the common striped squirrels or chipmunk (*Tamias striatus*) appeared anywhere in the region.

Other species of squirrels were very common, the red fox, gray and black squirrels, and especially that pest of farmers, the striped gopher (*Spermophilus lineatus*), were everywhere abundant. I well remember the first specimen of a chipmunk which I saw after two or three years residence in that section. I met him about five miles in the direction of Fox river on his emigrating tour northward. He had taken up his temporary residence under the roots of an old stump, on the top of which he was perched uttering his characteristic "chip" a note which the other species never produce. He was soon followed by numerous others and the two species lived together for a while, as far as I could observe, without any discord. The four-lined squirrels, however, soon became less numerous and in a short time were so scarce that it was difficult to obtain specimens and they have long since entirely disappeared from that region.—Moses Barrett, M. D., *Milwaukee, Wisconsin.*

Notes on Two little-known Birds of the United States. —Baird's bunting (*Centronyx Bairdii*) is the most abundant and characteristic species along the northern border of Dakota, between the Pembina and Turtle Mountains—in some places out-

numbering all the other birds together. It is surprising that so common a bird should have resisted research, as this one has, for thirty years. Its history is somewhat peculiar. Discovered by Audubon on the Yellowstone, in 1843, the original specimen, still preserved in the Smithsonian, has remained unique until the present year. It was described and figured by Audubon (Birds of America, vii, p. 359, pl. 500) under the name of *Emberiza Bairdii*, and in 1858 was made the subject of an elaborate article by Prof. Baird, who instituted for its reception the genus *Centronyx*. This name, however, is scarcely tenable, the structural peculiarities being so slight that the bird might very properly stand as *Passerculus Bairdii*, if the original generic designation be considered too broad for present use. (The species is so much like a savanna sparrow that it was some days before I learned to tell the two apart, at gunshot range, often shooting one by mistake for the other.) The literature of the subject rested mainly on these two articles until 1869, when "*Centronyx Bairdii*" came again on the *tapis*, through the announcement of its discovery in Massachusetts (see Maynard, Am. Nat., iii, 1869, p. 554, and Nat. Guide, p. 112: see also Allen, Am. Nat., iii, p. 631, and Brewster, Am. Nat., vi, 1872, p. 307). This, however, was a mistake: the supposed *Centronyx* proving to be a *Passerculus*, believed by Mr. Maynard to be new, and by him afterwards named *P. princeps* (Am. Nat. vi, 1872, p. 637; see also Coues, "Key," pp. 135, 352). In noticing these points last year, in the "Key," as just quoted, I rather cast suspicion upon the true species itself, by venturing upon the gratuitous presumption that a second specimen of *Centronyx* would never be found. This was decidedly the greater blunder of the two — to tell how I happened to be led into it would not interest the general reader. So matters stood till this year, when Mr. C. E. Aiken took, in Colorado, a *Centronyx* which was considered to be a second new species of that genus, and was published as such under the name of *C. ochrocephalus* (Am. Nat., vii, 1873, p. 237). The writer of the article in question takes pains to point out certain slight discrepancies in size and form between the type specimen of *C. Bairdii* and the single specimen of the supposed new species, and lays particular stress upon a difference in the coloration of the heads of the two. Now I have not yet seen the new bird, and will not risk the chances of being twice mistaken about one species; but this is certain: that the ascribed specific charac-

ters fall entirely within the normal limits of individual variation in this or any other one of our sparrows.* My specimens of Baird's bunting, over fifty in number, including both sexes, all ages from the nest upward, and various changeable states of plumage, run from 5·10 to 5·85 in length, by 9·10 to 9·90 in extent, and show variations to match in other dimensions and proportions of parts. As to color, they range from some with the head-stripe only faintly buffy-gray, to others with this part rich golden-brown (just as in the golden-crowned thrush) and the rest of the head suffused with the same color; these extremes shading insensibly into each other. Some of the youngest specimens differ still more from the adults; being in a plumage hitherto unknown, and one so decidedly peculiar that under other circumstances of capture they might not have been referred to *Centronyx* at all. I shall take another occasion to complete the biography of *Passerculus Bairdii* respecting which my notes are now quite full.

Next to Baird's bunting the Missouri skylark (*Anthus Spraguei*) is one of the commonest birds which breed on the prairie region above indicated, about equalling in abundance the chestnut-collared bunting (*Plectrophanes ornatus*). It is another example of the curious fact that a very abundant bird, and one inhabiting no inaccessible region, may by mere accident remain for years almost unknown. Of this species, introduced to us under the same circumstances as those attending the discovery of Baird's bunting, I never, until this season, saw but two prepared specimens; Audubon's type, and one other, taken on the Saskatchewan by Capt. Blakiston, both in the Smithsonian. Another taken at Fort Randall, Dakota, by Capt. J. P. McCown, is said to be in Mr. Lawrence's cabinet. I am satisfied that I saw the bird myself at Fort Randall early last spring, but I can show no specimen to vouch for the statement. This summer, however, I have collected a large number, at various points along the 49th parallel. Among them are some nestlings just ready to fly, in a very pretty plumage materially different from that of the adults. Others show the transition toward the mature state. Fresh measurements of adult individuals exceed some that have been recorded in my work and elsewhere; the length being up to 6·50, the extent to 11·00, the wing to 3·30; an average is about 6·25×10·60×3·20.—E. COUES.

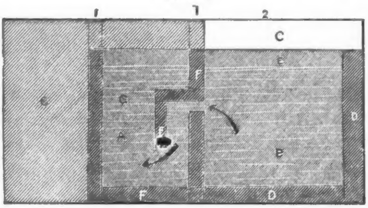
*Information received from Prof. Baird since the above was written confirms my impression that *C. ochrocephalus* is the same species, in autumnal plumage.

MICROSCOPY.

A New Growing-cell.— Having lately had occasion to examine some minute forms of life, and finding that, from some cause or other, most of the growing cells failed to work well continuously, I made a growing-cell similar to the following sketch, which I trust some readers will find useful.

Cut two pieces of moderately thick crown glass, one 3 inches by $1\frac{1}{2}$ inches, the other $1\frac{3}{4}$ inches by $1\frac{1}{2}$ inches, cement these together with Canada balsam; when dry, fix with the same cement two slips of glass of the same thickness to the other end of the slip, so as to form the sides of the reservoir (D D); also fix with gold-size slips of thin glass, so as to form the sides of the growing-cell (F F F F); when quite dry, cement a piece of thin glass $2\frac{1}{4}$ inches by $1\frac{1}{4}$ inches over all — care being taken that a very small quantity of gold-size is used, or it will run into the growing-cell. When used, fill the reservoir with fresh water until it runs into growing-cell A, and both are at the same level. The object (the growth of which it is desired to observe) may then be placed in the cell. If made of these dimensions, the water in the reservoir B will continue to supply fresh water to the growing-cell for at least three days without being refilled; of course, if the reservoir is made larger, it will last longer than this.

Fig. 174.



References to illustration: A, growing-cell; B, reservoir fresh water; C, glass slip 3 inches by $1\frac{1}{2}$ inches; D, side of reservoir; E, thin glass $2\frac{1}{4}$ inches by $1\frac{1}{4}$ inches; F, sides of growing-cell; G, growing object.— Jno. H. Martin, *Micro. Assay Laboratory, Maidstone, England.*

Revival of Animalcules after Desiccation.— Mr. Henry Davis discusses this old and curious question in a recent contribution to the Royal Microscopical Society. He finds that Pritchard and Carpenter and nearly all modern scientific writers have aban-

doned the doubts raised by Ehrenberg and others, and believe in the revivification of rotifers, tardigrades, etc., after complete and unlimited desiccation. His own experience with a colony of rotifers which he received by post in a few grains of dry, dusty powder, and almost immediately brought to life by watering it in a stage-tank, was suggestive, certainly, of wonderful powers of endurance. He narrates the history of this colony as follows:—

"Since its establishment in 1867, it has received no new immigrants, but as it increased and multiplied, some of its members, in a dry state, have been removed to stock new tanks for my friends. It is generally kept in a cabinet, with other objects, and watered for examination when required, or, as a rule, once a month; so small a quantity of water dries up rapidly in summer; in a day sometimes. The longest time it has kept continuously dry is ten months; in winter, after watering, it has been frozen into a mass of ice; it has been heated on a brass mounting-table, with a spirit lamp very often, in order to melt the marine glue when a new cover has been required; it has been exposed dry to the sun in a photographer's glass room, all through a broiling summer; taken a sea voyage to the south of Spain, revived there and brought home again; taken to Ceylon; to India; revived on ship-board, to the astonishment of the passengers; brought home, and a few of the dry inhabitants immediately posted off again to a friend in Ceylon, who revived and has them still. As a final indignity and injury this much enduring family has been put into the receiver of an air-pump for twelve hours and thoroughly exhausted. This was almost too much for it, but still there is a little life in the tank."

Experimenting on this subject, he found that, while some could survive a short exposure to a heat of 200° (Fahr.), a thorough baking or boiling for two or three hours killed them all. Drying for a week in an exhausted receiver along with sulphuric acid was also fatal. He admits proof of revival after four years' torpor; though he failed in experiments extending over only from one to three years. Though nearly all authorities agree in the books as to the desiccation theory, yet many good observers privately doubt whether those that revive were really dried at all; and Mr. Davis is satisfied that the non-revivers are the dried ones, and those which revive do so because they were not desiccated. He has observed that the creatures constantly give off a slimy secretion; and in drying they contract into an ovoid form, and the gelatinous fluid dries over them into a thin hard shell which protects them from further drying. If isolated rotifers are dried upon a clean glass

slide they seldom revive; because they crawl about until the last moment, and thus part with so much of their protective covering that they are finally dried up and destroyed.

Notwithstanding the first impression of some of the Fellows of the Society, that Mr. Davis' researches had been entirely anticipated by many continental authorities, the doctrine of the gelatinous envelope seems to be an entirely original as well as a very satisfactory settlement of a much disputed question.

Action of Poisons on the Blood Corpuscles.—Dr. Osler read a paper before the Medical Microscopical Society, in London, giving the results of his experiments on the action of solutions of the sulphates of atropa and of physostegia upon the blood corpuscles. He hoped to show, in the corpuscles, the already demonstrated antagonism between these reagents, but reached an exactly opposite result, both solutions checking in a somewhat similar manner the amœboid movements of the white corpuscles, and both causing the red corpuscles to become irregular from involutions and cuppings of the surface. The reagents mixed produced the same changes as when separately applied. Solutions of curare were also mixed with blood, but produced no positive results.

Limit of Resolving Power. — How little we appreciate the extent to which the resolving power of our best objectives falls below the possibilities of their amplifying power, was well illustrated by the surprise of many microscopists, and the incredulity of some, when Nobert's 19th band, of 112,000 lines to the inch, was beautifully resolved by a power of scarcely over two hundred diameters; while, with absolutely faultless definition, the same lines ought to be visible under a much lower power than that. What we ought, theoretically, to be able to see with powers of from one to three thousand diameters, is computed in the following curious extract from one of Dr. Pigott's recent papers.

"With regard to these minute quantities [beading one hundred thousandth of an inch in diameter, etc.], and to remove doubts which may arise in some persons' minds as to the possibility of seeing such very minute linear quantities, I may say that a minute of arc corresponds to the breadth of the 334th part of an inch as seen at ten inches, which is at least four times as thick as a human hair at that distance. Now the one hundred thousandth of an nch under a power of 1,000 is precisely the same thing as a thous-

andth of an inch under a power of one, or seen naturally at ten inches. But we can see hairs much finer than this — say three times — therefore, with regard to arc, we can see with a power of 1,000 the $\frac{1}{3}$ of $\frac{1}{100000}$, *i.e.*, with a power of 3,000 about the millionth. To find the angle in seconds, $1'' = 0.000004848 = \frac{5}{1000000}$, nearly.

The angle under a power of 3,000, at a distance of ten inches, is for a millionth of an inch. . . . . $\left.\right\} = \frac{3.000}{10 \times 1000000} = \frac{3}{10000}$

Divide this by the value of one second and we get six seconds in the angle subtended by $\frac{1}{1000000}$ under a power of 3,000."

Use of Micro-photographs.—The experience of the late siege of Paris has given a permanent prominence to microphotography as a practically useful art. A French engineer now proposes to reduce messages photographically to microscopic size, and then blow them through a pneumatic tube under the straits of Dover to England, where they should be raised by photography to a legible size again. Thus the promptness of the telegraph would be approached, while its expensiveness, in the case of long messages, would be avoided.

Structure of Diatoms.—In stating Mr. Stodder's disbelief that the silicious matter in diatoms was always deposited in spherules, we omitted to explain that it was the processes, or so-called feet, of *E. Argus* which he considered structureless. Mr. Stodder also desires us to notice that he does not adopt Mr. Slack's term "ordinary diatoms;" that he has not believed the markings on all diatoms to be depressions, but that the dark spots seen by reflected light on *E. Argus* are so; and that he and Mr. Wells have not been associated in studying this subject. He also contributes the following remarks in regard to test objects and high powers.

"The histologists, vegetable and animal anatomists may say as they have said, 'What of it? Is it worth the time and labor required to determine whether the minute granule of one fifty thousandth of an inch is hexagonal or circular, a bead or a cavity?' Yes, gentlemen, it is, for so long as these questions are unsettled, so long must you be uncertain of the true interpretation of your own observations; so long as you do not use the best instruments and the highest powers, so long must you be ignorant of

the undiscovered, uncertain whether you have found all that can be found. No better tests are yet known of the quality of microscope lenses than the diatoms and Nobert's lines. To know that you have obtained the best results in your own specialties you must know what your instruments can do on known objects; to 'increase knowledge' in your own departments, you must use the best instruments and the highest powers the skill of the optician can produce. Science cannot be much advanced by the use of lenses of twenty years ago."

METHODS OF STUDY IN INFUSORIA.—An abstract of an extremely suggestive paper relative to this subject is given under "Reviews" in this number of the NATURALIST.

CORRECTION TO NOTE ON APERTURE.—"Improved assumption" p. 567, line 1, should have been printed "unproved assumption."

NOTES.

THE Kansas Academy of Science held its sixth annual meeting at Lawrence, Kansas, on Sept 11 and 12. This Academy holds its annual meeting of two or three days duration in different places in the state. Papers are read on various subjects, and considerable work is done for the encouragement of science throughout Kansas. Quite a number of papers were read, and a special address was delivered which was anti-Darwinian in character. Among the papers falling in our sphere for notice, was one by Prof. F. H. Snow on "Injurious Insects," and one by Prof. B. F. Mudge on the "Discovery of Fossil Footprints in Osage County," of "middle permian" age. Several hundred tracks were collected and will be sent to Prof. Marsh at New Haven. Another paper by Prof. Mudge was on the "Mound Builders." The evidences of this ancient race in Kansas consisted in finding deposits of pottery, indicating ancient villages, but we do not note anything in the description of the remains that prove them to be those of mound builders any more than of Indians of more recent date. No mounds are mentioned, and, until the pottery found has been carefully compared with that unquestionably made by the mound builders and the Indians, the particular race whose remains are described must be left in doubt. The following is the most interesting part of the paper as reported:—

"But the most important locality seen by us in Kansas lies not

far from Asher creek, on the southwesterly side of the Solomon river, in Cloud county. The locality is on a rolling prairie, just above the river bottom, which is here quite narrow. The most marked feature of this village is the pottery, where their domestic articles were manufactured. It covers an area of from one-fourth to half an acre, rising irregularly at the highest point about two feet above the level of the adjoining prairie, and is composed to a great extent of the materials and debris from the old workshops. In it we found a considerable quantity of the clay, dug from the banks of an adjoining ravine, which had never been moulded; and some partly moulded and sometimes mixed with straw, probably to be used in the coarsest articles. Also fragments from what appeared to be the ovens in which the pottery had been baked. These fragments showed marks of fire, and were too clumsy and coarse to have been part of any household utensils, and were mostly in a heap in the highest and central part of the village. The extent of the village was obscure, as the rank grass had covered the ground for long ages and nearly obliterated all traces of what once existed."

The next meeting will be held at Topeka, in Sept., 1874. Prof. Snow was elected president, Prof. Fraser retiring from the chair.

THE first award of the Grand Walker prize of $1,000 was voted by the Council of the Boston Society of Natural History, on Oct. 1, to Mr. Alexander Agassiz of Cambridge, for investigations on the embryology, structure and geographical distribution of the Radiates, and especially on the Echinoderms, and the publication of the results as embodied in his recent work.

The Annual Walker prize, for 1873, of $60, was, at the same meeting, awarded to A. S. Packard, Jr., for his essay on the development of the common house fly.

A VERY deserving institution has recently been established in Cincinnati, under the title of the Cincinnati Acclimatization Society, its object being to effect the introduction of such foreign birds as are worthy of note for their song or their services to the farmer or horticulturist. The society announces that during last spring it expended $5,000 in introducing fifteen additional species of birds, and that it has already successfully accomplished the acclimatization of the European skylark, which is stated to be now a prominent feature of the summer landscape in the vicinity of Cincinnati. Among the species which it is proposed to introduce is the European titmouse, considered abroad as one of the most successful foes of insects injurious to vegetation.—*Nature.*

PROFESSOR MARSH'S exploring party returned to Fort Bridger, Wyoming, Sept. 5th, after a most successful trip of six weeks, among the Eocene fossils of the Uintah mountain region. Many interesting discoveries were made, especially of new mammals, birds and reptiles. The party are now at work in Oregon, and will return east in December.

ANSWERS TO CORRESPONDENTS.

C. M., Mass.—The objects sent are an early and peculiar stage of development of a fresh water polyzoon. They are popularly labelled "eggs" of *Cristatella*, but more accurately statoblasts or pseud-ova.—R. H W.

BOOKS RECEIVED.

Berliner Entomologischer Zeitschrift. Yahrgang 1-10. 8vo. 21 pamphs. Berlin, 1857-1866.

The Principle of the Least Action in Nature, illustrated by Animal Mechanics. By Samuel Houghton. 8vo. pp. 48. London, 1871.

La Vie au Point de Vue Physique, ou Physiogenie Philosophique. By Charles Girard. 12mo. pp. 70. Paris, 1870.

Sixth Annual Report of the U. S. Geological Survey of the Territories, embracing portions of Montana, Idaho, Wyoming and Utah; being a report of progress of the year 1872. By F. V. Hayden. 8vo. pp. 844. Washington, 1873.

Report of the Commissioner of Education for the year 1872. Cloth 8vo. pp. 1018. Washington, 1873.

Proceedings of the Lyceum of Natural History in the city of New York. Second Series. Jan. 3-March 3, 1873. 8vo. pp. 32. New York, 1873.

Proceedings of the Trustees of the Peabody Educational Fund at their Annual Meeting, New York, July 16, 1873. 8vo. pp. 61. Cambridge, 1873.

Meteorological Observations, during the year 1872, *in Utah, Idaho and Montana.* 8vo. pp. 120. Washington, 1873.

A Catalogue of the Shell Bearing Mollusca of Rhode Island. By Horace F. Carpenter. 4to. pp. 4. 1873.

Circulars of Information of the Bureau of Education. Nos. 1 and 2. 8vo. Washington, 1873.

The Mechanical Equivalent of Heat a Delusion. By A. Arnold. Sept., 1873.

The Tourmaline. By A. C. Hamlin. Cloth 8vo. pp. 107. With 5 colored plates. Boston, 1873.

The Entities and Thoughts on Development and the Origin of Species. By C. G. Forshey. 8vo. pp. 9. New Orleans, 1873.

Tidsskrift for Populære Fremstillinger af Naturwidenskaben. 8vo. Fjerde Række. Femte Binds. Fjerde Hefte. Kjobenhavn, 1873.

Twenty-first Annual Report of the Regents of the University of the State of New York on the Condition of the State Cabinet of Natural History. 8vo. pp. 190. With 13 plates. Albany, 1871.

Twenty-second Annual Report of the Regents of the University of the State of New York on the Condition of the State Cabinet of Natural History. 8vo. pp. 113. With map. Albany, 1869.

Fifty-fifth Annual Report of the Trustees of the New York State Library. 8vo. pp. 192. Albany, 1873.

Twenty-fourth Annual Report on the New York State Museum of Natural History by the Regents of the University of the State of New York. Cloth 8vo. pp 232. With 8 plates. Albany, 1872.

Annals of the Dudley Observatory. Vol. i. 8vo. pp. 319. Albany, 1866. Vol. ii. Cloth 8vo. pp. 567. With 36 diagrams. Albany, 1871.

Results of a Series of Meteorological Observations, made under instructions from the Regents of the University at sundry Stations in the State of New York. Second Series. From 1850 *to* 1853, *inclusive; with records of rain-fall and other phenomena, to* 1871, *inclusive.* Prepared from the original returns by Franklin B. Hough. Cloth 4to. pp. 402. Albany, 1872.

Description of a Species of Caligulus, C. Americanus. By Charles Pickering and James D. Dana. (From Am. Jour. Sci., Vol. xxx, iv, p. 225, 1838.) 8vo. pp. 106. With 3 plates.

Popular Science Monthly. New York, Sept., Oct., 1873.

Revue Scientifique. Paris, Aug. 2 - Sept. 27, 1873.

Field. London, July 26 - Sept. 20, 1873.

Land and Water. London, July 26 - Sept. 20, 1873.

Bulletin of the Torrey Botanical Club. New York, July - Sept., 1873.

The Lens. Chicago, Aug., 1873.

Journal of the Franklin Institute. Philadelphia, Sept., Oct., 1873

The Entomologists' Monthly Magazine. London, Oct., 1873.

Grevillea. London, Oct. 2, 1873.

Journal of Botany. London, Oct., 1873.

Academy. London, Aug. 1 - Oct. 1, 1873.

Nature. London, Aug. 7 - Oct. 2, 1873.

Le Naturaliste Canadien. Quebec, Aug., Sept., 1873.

American Journal of Science and Arts. New Haven, Sept., Oct., 1873.

The Gardener's Monthly. Philadelphia, Sept., Oct., 1873.

Geological Magazine. London, June - Aug., 1873.

The Horticulturist. New York, Oct., 1873.

Annals of the Lyceum of Natural History of New York. March-June, 1873.